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49.2018.

A G U I D E
TO THE PROPER
REGULATION OF BUILDINGS IN TOWNS,
AS A MEANS
OF PROMOTING AND SECURING THE
HEALTH, COMFORT, AND SAFETY
OF THE INHABITANTS.

HEALTHY HOMES.

A

Guide to the Proper Regulation

OF

BUILDINGS, STREETS, DRAINS, AND SEWERS;

WITH

A POSTSCRIPT ESPECIALLY ADDRESSED
TO SURVEYORS AND COMMISSIONERS OF SEWERS.

By WILLIAM HOSKING, ARCH^T. & C.E.,

ONE OF THE OFFICIAL REFEREES OF METROPOLITAN BUILDINGS, AND PROFESSOR OF THE
PRINCIPLES AND PRACTICE OF ARCHITECTURE, AND OF ENGINEERING
CONSTRUCTIONS, AT KING'S COLLEGE, LONDON.

A NEW AND CHEAPER EDITION.



LONDON:

JOHN MURRAY, ALBEMARLE STREET.

1849.

LONDON: PRINTED BY WILLIAM CLOWES AND SONS, STAMFORD STREET.

ADVERTISEMENT.

THE course of events since the first publication of this book has justified the warning given by the Author in the Postscript to it; whilst experience of the mischiefs which have arisen from attempts to remove the consequences of a wrong or otherwise defective practice has led to a recognition of the importance of a right practice in matters of Drainage and Ventilation.

The application of the principles laid down in this book enabled the Author to predict the consequences which have followed upon a hurried and imperfect course of proceeding in the Metropolis, aggravating the evil which it sought to remedy; and he believes that a proper understanding by the public of these principles would tend to check the continuance and to prevent

the recurrence of wrong practices in this matter ; —a matter of no small importance, inasmuch as it affects the health and the lives of the whole community.

A large part of this book is devoted to the subject of Drainage and Ventilation, treated in a popular manner, and so that the principles may be easily understood ; and the Author is induced now to offer the book to the public in a cheaper form to obtain more extended circulation for the information which it contains, in the hope that it may lead to the above-stated effect.

London, August, 1849.

CONTENTS.

	PAGE
PREFACE	7
INTRODUCTION	11
REGULATION OF BUILDINGS	63
PLACING OF BUILDINGS WITH REFERENCE TO ONE ANOTHER	67
ARRANGEMENT OF STREETS IN TOWNS	71
SAFE STRUCTURE OF BUILDINGS	74
SECURITY OF BUILDINGS AGAINST FIRE	102
DRAINAGE AND VENTILATION	189
DRAINAGE OF BUILDINGS	191
VENTILATION OF BUILDINGS	213
INCONVENIENCES ARISING FROM PROJECTED BUILDINGS AND PROJECTIONS FROM BUILDINGS	242
 POSTSCRIPT.	
THE REPORT OF THE METROPOLITAN SANITARY COMMISSION, AND THE CHOLERA	265
 APPENDIX.	
I. Rates of Insurance for Warehouses in London.	279
II. Bell-traps	280
III. State of Sunderland	282

P R E F A C E.

IN bringing to a conclusion the self-imposed task, of which the result appears in the following pages, the necessity of stating in the title-page his official connection with the administration of the Metropolitan Buildings Act, calls the author's attention to the propriety of intimating in this place that his little book possesses no official character, and is of no official authority whatsoever. The opinions herein contained are his own, and he alone is accountable for the expression of them. Many of the instances cited in illustration have come to the author's knowledge in the performance of his official duties, certainly ; but he breaks no confidence in stating them, as they are all upon record in some form or other, and the records are open to public inspection ; whilst some are due to the ordinary sources of general information, and the rest are either derived from private sources, upon

which he believes he can rely, or they are the results of his own personal observation.

The sequence of the subjects indicated in the title has not been strictly adhered to, nor was it possible, indeed, to treat of them severally without repeating under each of the several heads much of what must occur under the others. The title must be taken, therefore, to set forth the general bearing which the Regulation of Buildings has upon the collective subject; and the author believes that it will be found from what appears in the following pages that he has not overrated the effect which buildings exercise, or are capable of exercising, upon the health, comfort, and safety of the inhabitants of towns, nor the importance of properly regulating them as a means of promoting and securing those essentials to the enjoyment of the social advantages which towns are supposed to present.

The author is quite conscious that many things herein suggested or described in words require the aid of illustrative diagrams to render the suggestions or descriptions of any practical utility; but being uncertain as to what general interest the matters alluded to may possess, he does not encumber this little volume with more than such mere indi-

cations as may serve to show of what the subject is capable, and in what its details may consist. If the sale of a small impression of the book in its present form should make it appear that the subject has got the better of any inability on his part to do it justice, by creating an interest for itself, it will, perhaps, become the duty of the author to prepare an edition with illustrative diagrams; or if an otherwise unattractive subject be found interesting as he has treated it, his own interest will probably lead him to endeavour to do what may be necessary to render his observations more practically useful than they can be without such illustrations.

London, December, 1847.

[The reader is requested to observe that the indented paragraphs which occur from time to time in the following pages, and break the text, may be read, or be passed over in reading, at pleasure, as they are merely incidental, and not necessary to the continuity of the subject. These paragraphs consist mainly of cases intended to illustrate or to exemplify the remarks which they appear to interrupt, and may be considered as parenthetical.]

INTRODUCTION.

REGULATION, whether it be of buildings or of any other matters at the disposal of individuals, can only be rendered effectual by the intervention of the Legislature ; and as regulation, when applied by statute, involves both restraint and compulsion, the purposes for which rules may be imposed, and the circumstances under which regulation is required, ought to be such as to command general acquiescence in the necessity and propriety of the imposition. Universal acquiescence in all the rules which it may be necessary and proper for the general good to impose is not to be expected, but certain rules may be laid down, of which the propriety will be generally consented to, although there will be individual interests to which some of such rules will be felt or be fancied to be repugnant. The propriety, for instance, of a rule prohibiting the formation of flaps or cellar-doors in the footways of a town would receive general consent, and a

law to enforce the removal of all such means of obstruction to the public way, and sources of danger to the public, which are found to exist, would hardly be thought harsh by any but those who have an interest in maintaining them ; especially if it were understood that by compelling the owner of the house for whose convenience a flap is made in a footway to abate the nuisance, he is not deprived of the means of getting casks into and out of his cellar, but only thrown upon a means of doing so within doors, and at far less inconvenience to himself than the public suffer from the out-door flap.

The mercer, or other neighbouring tradesman, however, who would readily consent to the propriety of abating the cellar-flap and the contingent dray-ropes to the beer-way of his neighbour the publican, on the same side of the street, because the obstruction they occasion to the footpath may drive customers, or other possible purchasers of their wares, to cross the street, does not hesitate to spread out sun-blinds with their stay-rods over the footpath before his own shop-window, and that without the slightest regard to the annoyance occasioned thereby to the general public. Both mercer and publican readily concur, nevertheless, in opinion, and they do not fail to urge it whenever occasion offers, that hucksters or

traffickers of a more humble grade should be prevented by law from depositing their goods and vending their wares in the streets, to the obstruction of the public way, and to the injury of the settled trader !

The abuses last referred to are not subjects proper to the Regulation of Buildings, perhaps—they are rather matters of police—but being familiar instances, they will serve to show that it may be proper to deny to individuals, and even to classes, what are conveniences to them, because the public comfort and safety require that they should be denied ; that the publican should have his beer-way with gear for lowering and hoisting barrels and casks inside his house, so that passengers may not be obstructed on the public way, and their lives and limbs endangered ; and that the mercer should shade his goods, if they must be shaded, without rendering the public way inconvenient to all passers by, who have occasion to carry loads on their shoulders, or indeed to wear hats on their heads, if they exceed five feet in their stature.*

* In no part of the world does the sun-blind nuisance exist to a greater extent than in London, where the Commissioners of Pavements throughout are authorized by statute (57 Geo. III. c. 29, commonly called Michael Angelo Taylor's Act) to regulate or remove all such things as are "inconvenient or inconvenient to any passengers along the carriage or footways

But in pointing out what is proper regulation as it regards buildings, it is not intended to urge that it is expedient to impose by law all that is proper to be done, and indeed it is not assumed that the best mode of doing everything proper to be done is either sufficiently ascertained in every case, or that some things may not be as well or even better done to the effect intended, than is herein set forth.

If, however, it be not expedient to impose all that it is proper to do in any case, it is certainly desirable that what is proper to be done should be done to the greatest extent possible; and much may be done without the intervention of the Legislature, by the constraint which takes the form of conditions or covenants, as between individuals. In this manner the owners of lands required in extending old towns, or in building new ones, may do much to promote the health, comfort, and safety of the future inhabitants, while they secure to themselves a more valuable

of any of the streets, &c." But Commissioners of Pavements are mostly of the class of sun-blind nuisance-makers themselves, and consequently the nuisance thrives, to the inconvenience and annoyance of the community at large.—Boards of Guardians in Ireland, who refuse to do what may be necessary to fulfil the purposes of the law which constitutes them, are superseded, and the district is charged with Guardians who are not only authorized, but *required* to give effect to the law.

property. But inasmuch as the observance of rules directed to objects not generally well understood, nor indeed fully appreciated by either builders or occupiers, would involve a departure from the beaten track, and demand of the builder some little additional care and forethought, although their observance may cost no more in money—the builders being the class of persons to whom the owners of land in the neighbourhood of towns address themselves, or by whom they are addressed, and who would, if general regulation be not imposed, seek rather the lands of those who would not constrain them, than of those who would require the observance of a code of wholesome rules,—regulation by law becomes necessary in all essential matters to protect the worthy from the unworthy, as well as to protect the public from the vagaries of any.

In asserting that all that is herein set forth as proper to be done, may be done without increased cost, such assertion is to be understood to have reference to things properly done. Builders who put slight and insufficient materials together, and in a slovenly, or, to use a builder's phrase, a scamping manner, and bedaub the product with plaster and paint to beguile unwary purchasers, cannot assuredly build solidly and durably for the same money; nor can the builder who trans-

fers to a purchaser a house to which a sewer has been built, as well as a road made, sell for the same price as if no sewer had been built. The purchaser must necessarily pay more for a well-built and well-drained, than for an ill-built and undrained house, but, buying the latter, he soon finds to his cost that he has bought too cheaply ;—the walls bulge, the floors gape and creak ; the lead on the flats and gutters, being laid without drips, after puckering in summer, cracks in winter, and as the snow thaws the ceilings fall ; whilst the cesspool overflows or returns its filth to the house by the drains which led it thither ;—he suffers in health and in purse, and thus the public by its members suffers. What it is intended to urge as a truth in making the assertion above referred to, is, that what is to be done honestly may be done wisely also, without increasing the real cost of the thing to be produced.

The propriety, and indeed the necessity in large towns, of establishing and of enforcing rules for preventing the spread of fire from one building to another are so generally admitted, that regulations to that effect are sure to receive general assent.

It is found in practice, nevertheless, that in London, of all towns the largest, and where

such rules are especially necessary, if they are necessary anywhere, efforts are made by individuals to evade the rules imposed by law to the effect indicated, as frequently as the convenience or even the caprice of the individual is subjected to their restraint. It may happen, indeed, that the rules actually imposed interfere unnecessarily with the right of private action in such matters, and as they are many, and are to some extent complex, it may be that in some cases they do so, but certainly not in all the cases in which evasion is attempted, nor in all the cases in which the law is resolutely set at nought, for there are many such, and many such there will be, wherever, as in London, the special statute is defective in the means of giving certain effect to its own provisions.

In the case of the Metropolis, regulations by statute to prevent the spread of fire are now of ancient date, and the experience of their beneficial effect in London, and of the mischievous effects which have been occasioned by fire where no such regulations have been in force, has led to the extensive adoption, of late years, of similar rules in the local Acts of many of our larger and more important provincial towns. But the root of the evil to be checked—the cause of the danger to be avoided—is the susceptibility of buildings, as they are commonly built in our towns, to take

fire and to burn, and this would seem to be as proper a subject of effective regulation as the limitation of fire to the building in which it may have originated.

Greater loss of life has occurred from the inflammable nature of the particular buildings, and the consequent readiness with which they have taken fire and burnt, than from the transmission of fire from one building to another. It is in the buildings in which the incendial fire originates, that loss of life occurs, and not in buildings to which any such fire may be communicated. People have time to escape from a neighbouring building before the danger reaches them, be the separation of the buildings ever so slight, but escape from a building in which the fire has been brewed, if the expression may be used, is too often found to be impossible. The Legislature has confined itself almost exclusively, hitherto, to providing for the protection of property ;—that is to say, its prescriptions have been to prevent the spread of fire from building to building, whereby property alone is hazarded ; whilst the danger to human life from fire originating in a building remains almost as wholly unprovided for by Legislative enactment as it was before the Fire of London. In the twilight of a summer's evening, while the inmates were almost all awake and stirring, Raggett's Hotel in Dover Street took fire, and, through the rapidity with which it burnt, many lives were lost ; whilst, but a few months be-

fore that event, four persons had been burnt to death in a house in Guildford Street, because of the inflammability of the inside of the building. In both these cases there were efficient arty-walls which prevented the fire from doing any serious injury to the buildings next adjoining laterally, and the brick external walls tended to protect the buildings opposite to the buildings burnt. With stairs of stone, or other substance not easily ignitable, supported by brick walls,—internal partitions of brickwork, or even bricknogged partitions,—floors less susceptible of fire than simple combinations of fir-joists and deal boards, intimately connected with and bearing upon hollow quartering partitions;—with these securities, or with some of them only, in the cases referred to, the combustion must have been, at least, far less rapid than it was, and the escape from death and mutilation of all the inmates in one of the two cases certainly, and probably in both, would have been secured.

To some slight extent the propriety of interposing to this effect has been recognised, so far as London and some other large towns are concerned ; that is to say, rules have been imposed by statute to check and diminish the danger to buildings necessarily connected with the employment of fire in chimneys, stoves, and furnaces inside the buildings.

Want, however, on the part of the Legislature,

of knowledge of the subject, or, it may be, of due consideration of its importance—fear, perhaps, of being in advance of public opinion ; or “*ignorant impatience*” on the part of the public of legislative interference with economical operations of any kind, have tended to leave buildings in England almost as inflammable within themselves as are the pine-built buildings of the towns of the United States, and of our own Colonies, in America. If however, it appear that buildings may be rendered far less inflammable than they are usually made, without materially increasing the cost of the buildings, whereby life will be less exposed to danger, and property be better protected from the destructive action of fire, the propriety of adopting arrangements to that effect will not be denied even by those who would refuse their assent to the imposition of rules to compel their adoption.

It can hardly be necessary to combat the vulgar error, that, so far as property is concerned, insurance throws the loss by fire upon the Insurance Offices, though it may be worth while to remark here, for the benefit of those who may be led into the error from want of reflection, that the insurers of property are the contributors to the funds of the offices, and that by insuring, people do but club together to save any one of their number, whom an accident by fire may befall, harmless, except to the extent of his own

contributions to the common fund, whilst the value of property so destroyed is like so much more added to the national debt.

But the error has another phase, and one of painful interest to the labouring classes of society. If a manufactory be burnt, the owner is congratulated by his fellow-insurers if he be sufficiently insured, but little thought is taken of the workmen's uninsured tools which have been destroyed, and still less of the loss of the men's labour to themselves, to their families, and to the community, until the manufactory in which they had been employed can be re-established, or they can find work elsewhere. And in like manner, and with more painful interest, as it regards the habitations of the labouring population upon a fire occurring in any of them. The owners of houses insure, and, if a fire happen, the houses are reinstated by the Insurance Offices, but the poor inhabitants, who have, in fact, paid for the insurance of the houses in the form of rent—and the more, the more hazardous the buildings—are thrown houseless and naked upon the world. Any endeavour, however, that may be made at any time to enact regulations, or to enforce whatever regulations may have been enacted, to render manufactories—the workshops of the labouring population, and cottages—the dwellings of the poor, less susceptible of destruction by fire, will be met by an outcry in the name of the poor !

While buildings are commonly erected of such

materials, and of materials so disposed as to render them unnecessarily susceptible of fire, they are designed for the most part with an utter disregard of what may be necessary to render them wholesome. Houses are built with doorways for convenience of ingress and egress, with windows for the admission of light and air, with chimneys and flues for the convenience of fires with which to cook food and to warm the apartments, and sometimes with drains as conduits for the fluid refuse which may arise in the use of the houses; but as an open window is almost if not wholly incompatible with a fire as a source of warmth to an apartment, and a fire will not burn without a constant supply of air, a door must be opened, or a draught be otherwise established for the supply of air from the outside of the house, or air must come up from the drains and bring noisome stench with it, or down the chimney and bring back smoke and soot.

If, again, it be made to appear that by means of easy and inexpensive arrangements these great evils may be remedied, and the wholesomeness of a house may be to a great extent secured, not only without diminution, but with increase of comfort in the use of the house, the propriety of imposing rules to compel the adoption of such arrangements would hardly be questioned by any.

But however true it may be that, without adding to the cost, houses may be built less susceptible of fire and more wholesome and comfortable than they commonly are built, it is to be feared that it is altogether out of the question to propose that any scheme, though certain of producing such results, should be at once made compulsory. Habit and prejudice, not to say obstinacy and ignorance, on the part of the classes whose clamours can sway the Legislature, would effectually prevent the enactment of any regulations which have not grown up with the people who are to be affected by them.

The admirable and efficient system of police now in force in all our large towns had nearly been crushed in its infancy by the clamour of prejudice, and it would, probably, have been crushed if it had been extended at once, as it has gradually extended itself, from the Metropolis to all the great and to many of the smaller provincial towns of the kingdom. The Metropolis must not boast, however, of having set an example in accepting the New Police System; the City with its four members could and did refuse to accept it, and the system was experimented "*in corpore vile*," and the rest of the Metropolis, not having then fourteen members to make its prejudices and obstinacy heard, was the *corpus* chosen for the experiment.

Example is, perhaps, the strongest influence that can be employed to induce the adoption of any regulations, however good, which are not of ancient date and common practice, and example may be made, without much objection, probably, of buildings for public uses. Churches, chapels, theatres, prisons, hospitals, workhouses, and even schools, and all such like buildings, whether built at the public or at private expense, ought to be subjected at once to whatever regulations may be necessary to render them safe in every respect—safe as to structure—safe from fire—and safe as it regards the health of those for whose use they are intended.

If the means of ventilating with proper effect were applied in every public building, the overcrowding of places of worship and of public amusement would not be of necessity pernicious to health; but without such means it seems very certain that fevers and other infectious diseases are propagated to a large extent, even if they are not generated, in overcrowded rooms. It lately happened that drawings of the plans, &c. of a small chapel in London were submitted at the office of Metropolitan Buildings for the opinion of the Official Referees as to the sufficiency of the walls to carry side galleries in addition to an existing end gallery; when it appeared that the chapel, being less than 45 feet long, is only 27 feet wide, and about

18 feet high, and that to its calculated capacity of 250 persons it was proposed to add 100 sittings more ! The slightness of the walls, that is to say, structural insufficiency, prevented the intended operation from being carried into effect in the manner proposed ; but if it had not been for this circumstance, and the necessity which the Metropolitan Buildings Act imposed of fire-proof stairs to the new galleries, from three to four hundred persons would have been huddled together for two or three hours at a time, almost night by night, and weekly almost throughout a whole day, into a space wholly unventilated (in the proper sense of the term), and not more than large enough for half the number at any time, even if well ventilated. It would be difficult, perhaps, to put a limit upon the admission of people into a chapel, theatre, or concert-room, but it would be easy to compel the thorough and efficient ventilation of every place liable to be crowded, as chapels and theatres are, with human beings for many hours together.

The necessity of submitting buildings in towns to regulation, and the extent to which regulation ought to be carried, will be rendered most clear by taking a view of the dangers attendant upon and incident to buildings in their structure and in their use, and of the inconveniences which they are susceptible of occasioning ; dangers and inconveniences none of which are necessary, but

which are consequences of general or of individual ignorance, wilfulness, or caprice, and which are also capable of being stayed by judicious regulations, and of being wholly prevented from occurring for the future, without injustice to any one, and with the best results as it regards the public.

There are dangers which may be designated direct, incident to the structure of buildings ; dangers which may be termed, in contradistinction, indirect, accruing in the use of buildings from defective drainage and ventilation ; and dangers arising from the employment of buildings for purposes which are themselves, or are capable of making the buildings, dangerous.

Direct dangers, or dangers which are attendant upon and incident to the structure of buildings, resolve themselves under two heads :—

1st. Dangers arising from defects in, or from injuries to, the structure.

2nd. Dangers arising from the liability of the materials employed in, or in connexion with, the structure to take fire and to burn.

And, first, as to dangers from defects in, or from injuries to, the structure of buildings :—

Buildings may be designed with the strictest

propriety as to their structure, and fall down, nevertheless, in course of building, from defective workmanship or improper materials; or, with the most effective workmanship and the best and fittest materials, from being deprived of certain artificial aids before effects, which time alone will produce, have been attained; or from being carried on in such manner as to expose the work to rain and wind, or other atmospheric influences, without due regard to the assistance which one part ought to have from another, or from other parts. Many sewers have fallen in, and tunnels have failed, from insufficient ramming or punning of the ground above and behind the structure; from the use of mortar as a setting material either so moist as to yield to the pressure to which it may be exposed upon striking the centres, or so dry and friable as not to adhere to the bricks; many arches and vaults have fallen upon the removal of the centering before even properly compounded mortar had set, and very many walls have fallen under the action of the

Before the ink was dry in which the preceding observations were written, the newspapers of the day recorded that "ANOTHER accident had occurred at the Hadleigh Station of the Eastern Union Railway, from the falling of a newly-built wall, which was blown down by the wind

upon a number of persons who were waiting on the platform to go by the Ipswich train. No one was killed, but about 60 persons were more or less hurt, some very severely."—*Spectator*, Sept. 18, 1847, p. 898. A wall which the wind could throw down when newly built, could never become a trustworthy wall, even as it regards the wind; it wanted mass, and—the consequence of mass—weight within itself, to enable it to withstand the force of the wind; or, as a light structure, it wanted breadth of base. Where or with whom the error lay does not appear. Possibly the wall had been designed to be of less than the height to which it had been carried, and counterfort or buttress piers may have been intended before or behind, to make up for want of base throughout, and omitted without reference to the designer. But be it as it may in that respect, incompetence or recklessness endangered the lives of a large number of persons, and severely injured some of them.

wind, or from undue pressure by scaffolds, ladders, or other matters, which would not have fallen if the return walls with which they may have been to be connected in the structure had been built up with them.

Last autumn (1846) a wall in course of building as a party-wall between two new houses at Brompton, near London, fell down, and one of

the workmen was killed by the fall. The accident was attributed to almost as many causes as there were persons giving evidence at the inquest upon the body of the poor man, but the opinion of the District Surveyor seemed to be that the pressure and movement, when in use, of the ladders against the scaffold which bore upon the wall induced "oscillation," which terminated in the overturning of the wall. Other persons attributed the fall of the wall to the compelled omission of timber in its structure, but neither witnesses nor jury seem to have remarked that none of the front and back walls of the houses, which should have been built up and bonded with the party-wall, had been built up with it, nor that a plea for bond timber to stiffen or secure otherwise insecure walls is a plea to entrust the safety of the walls which require such assistance to a substance liable to shrink, to rot, and to burn—in any case useless, and always ready to be mischievous.

Add, however, to the contingencies which may occasion the failure of well-designed structures, the consequences of bad structural arrangements, of unskilful workmanship, and of undue aiming at cheapness, and further and extensive sources of danger appear; since the use of foreign aids, such as bond timber, straps and bolts, struts and shores, furnishes the precarious but only means of holding together and keeping buildings erected

under such circumstances from becoming ruinous even before they are finished.

Moreover, buildings may have been built securely, and yet be rendered dangerous by ill-contrived, ill-directed, unskilful or careless operations in effecting alterations in the building itself, or in, or in connection with, adjoining or neighbouring buildings.

Time soon produces marked effects upon buildings built defectively, or made defective as above indicated, and the walls, tottering upon bad foundations, bulged perhaps through the shrinking or the decay of the timber laid in them, or overhanging from any of the many contingencies to which they are exposed, maintain a precarious security until the jolting of a loaded dray or the jarring of a fast driven omnibus occasions the fracture of a piece of rotted timber, or the failure of a rusted nail or bolt, and lets them down by the run. Strutting and shoring are sometimes applied to arrest a threatened fall; establishing, with raking shores which intercept the way, an enduring nuisance in checking an immediate danger; or otherwise by struts across over the heads of passers by, liable to fall upon them as the timber decays or becomes loosened in shrinking, merely deferring the threatened danger, and creating an additional cause of reasonable alarm.

Many of the causes which tend to render buildings dangerous in matters incident to their structure are latent, whilst some are exposed to view and are unsuspected because of their familiarity, or disregarded because of their supposed innocuousness. Latent causes most commonly consist in originally defective materials or workmanship, or in the decay of materials in parts not open to view. Familiar causes are, as before intimated, operations effected in and upon buildings by unskilful or careless persons in effecting alterations; and such also are choked watercourses, whether drains or rain-water trunks, which lead to the softening of the ground under piers and quoins, and to the destruction by the same process of brick or stone-work, and to the rotting of plates and posts of timber.

A rude and common, but unsuspected cause of danger presented itself in its effects not long ago within the operation of the Metropolitan Buildings Act. The party-wall between two houses formed also one side of a covered way from the street, to which the houses fronted, to a stable-yard and mews behind; and in process of time the brickwork of the wall, together with the foot of a story-post, which stood at one end of the party-wall to assist in carrying the front walls of the buildings, having been exposed to the action of urine, had

rotted, and failing therefrom, the two houses parted by it both became dangerous, and had to be dealt with accordingly.

But it is so difficult to tell how much longer it will take to soften the ground under, or to produce the requisite extent of decay in the substance of a quoin, of a pier, or of a story-post, to render the building depending thereon certain to fall, or what casualty may bring about the failure of the insufficient supports of a structure, that it seems hardly possible to check the sources of danger with too much strictness while buildings are in course of erection, or to forbid too firmly the performance of operations affecting the structure of buildings after they have passed out of the hands of the builder, without proper supervision on behalf of the public; for it cannot be doubted that it is the duty of the State to protect the poor and the ignorant members of a community from danger in the use of buildings, as well as to protect neighbouring inhabitants and the public generally from all possible contingent danger that can be checked and prevented, whether it be from precarious buildings or from any other source.

It happened in the course of last year (1846) that a tradesman in one of the principal streets in the City of London, desiring to set up a print-

ing-press in the lowest or basement story of his house, and the story not being high enough to receive it, he directed an excavation to be made below the floor of that story to obtain the requisite height. The excavation being made, and to a greater depth than the foundations of the walls of the building, the ground yielded towards the excavation under the weight of the building, and consequently the walls began to settle down. The attention of the surveyor of the district was called to the proceeding by the next neighbour on one side, who had found all at once that his doors and windows had become fixed, and that the large panes of glass in his shop-window were breaking one by one; and it appeared upon investigation that prompt measures were necessary to prevent the most serious consequences. In this case the inmates of the house, as well as the neighbours and the public, were protected from any serious disaster by the intervention of the public officer; but the neighbouring shopkeepers suffered great injury, and the public were subjected to great inconvenience by the requisite hoarding and shoring, which for many months occupied the pavement and narrowed the carriage-way before the house in question, and consequently occasioned the choking of the thoroughfare in the most crowded line of street in London.

It happened, in London too, in the same year, that a furnace chimney-shaft was built to a height from the ground of about 40 feet, upon a base four feet square. When this chimney

was brought into work, the smoke, or other product of combustion in the furnace which was laid on to it, was found to be offensive to the neighbourhood, and the chimney was at once raised to a further height of more than 40 feet, making a total height exceeding 80 feet upon a four-foot base, that is to say, of 20 diameters in height, and exposing plane sides to the wind. If it be considered that this chimney was of a light substance—brickwork—and hollow, and that the Nelson column, in Trafalgar Square, which is round in form, built of granite, and solid, had somewhat of its designed height of ten diameters, or of thirteen diameters, perhaps, with the capital, and statue upon it, abated, because of the apprehended insecurity of a structure of so great height in proportion to its base, the almost certain danger of the chimney-shaft referred to will be readily perceived. It is true that stay or guy-rods of iron were carried from the chimney-shaft to the roof of the building, out of one of the walls of which it grew; but it is most certain, that in the event of fire happening in the building and destroying the roof, the chimney would have been thrown down through the agency of the rods, whilst the aid of guy-rods to such a structure against wind is far from being so certain as to justify the erection of a chimney-shaft of such proportions as render it uncertain without stay-rods.

The very common practice in all large towns

of omitting or of removing the outer walls throughout the ground-floor story on two or more of the sides of corner houses, to admit of returned shop fronts, is so fraught with danger as to make it matter of wonder to all who know upon what a thread such buildings hang, that casualties from this cause are not of more frequent occurrence. Commonly a doorway is made upon a canted or diagonal line cutting off the corner where two fronts intersect, and leaving the quoin or outer angle of the building above to overhang a void; whilst the support given to the brestsummers placed under the walls of the upper stories is generally either slight fir story-posts, or even slighter iron columns, and which supports are not unfrequently placed over openings in the walls below, and almost always over timber in some form or other, in situations and under circumstances most liable to induce decay. Plastering and joiners' fittings cover up the parts upon the soundness of which so much is made to depend, and consequently danger will hardly appear unless accident develop it in such manner as to attract attention in time to avert it, until the wretched fabric falls upon the heads of the indwellers, and of those persons who may be otherwise within reach of the ruin.

Connected in some degree with the practice

of removing outer or front walls at the street level, and substituting mere posts as stilts to the walls above, is that of cutting away chimney-breasts from side and party walls for the same purpose of fitting the ground-floor story of a house for a shop, and, as commonly performed, it is both destructive and dangerous. The overhanging upper parts of the breast and the superimposed chimney-shaft are too commonly left dependent upon inadequate or otherwise improper supports, and almost invariably the wall from which the breast projects, and which it overhangs, is pulled over to one side, and so as to render the early condemnation of the wall imperative, whilst it is always to be considered in a greater or less degree dangerous.

In the metropolitan district the operation of the Metropolitan Buildings Act has stopped the practice of cutting away chimney-breasts without proper precautions, and to some extent the stilting of buildings upon posts is checked, but it is not stayed; the operations to that effect upon corner buildings being almost free from control.

Another modern practice which brings with it a hitherto almost unchecked source of danger is the use of bearing beams and girders of cast-iron. Accidents from this source are of frequent

occurrence, and as the practice extends itself daily, the danger is, of course, increasing. Used in brestsummers to carry walls, and in story-posts, cast-iron is a dangerous ingredient in the structure of a building in the event of fire, because of its liability to break when dashed with water, as well as to soften and even to fuse when acted upon by intense heat; but cast-iron is less dangerous, nevertheless, in brestsummers and story-posts, which are not generally exposed to concussive action, than in beams and girders to carry floors, upon which movement takes place.

Secondly:—As to danger arising from the liability of the structure of buildings to take fire and to burn.

This, it may be thought, is a class of dangers to which buildings are needlessly exposed when they are exposed to it at all. Exclude all inflammable and otherwise combustible materials from the structure of a building, and although a fire might by accident occur to, and injure or destroy the contents of the building, it could not touch the structure, and consequently must be limited to the compartments of the building, as well as confined within the building itself. And this is true of buildings generally, but it is not so of

warehouses which are used as depositories of goods of an inflammable nature, when these are in very large quantities. Nor is the exclusion of actually combustible substances, such as timber, from the structure of a building, an assurance that the building will be safe in case of fire, since fusible substances, as lead and iron, and substances liable to crack and break across if dashed with water when in a heated state, as cast-iron and many kinds of stone are liable, are not to be trusted if the contents of the building may themselves burn, and with sufficient effect to bring out the defective points in the character of the classes of substances alluded to.

Generally, however, a very large proportion of the dangers to which buildings are exposed from fire, because of the timber employed in them, arises from the injudicious use of timber rather than from its employment for the purposes for which it is so well adapted. But when it is considered that a large amount of the danger to which buildings are exposed through defects in their structure, arises from the liability to shrink and to rot of the same material which exposes them most largely to danger by fire, it is surely worthy of consideration how far, consistently with a due regard to economy and to convenience, the material referred to can be excluded from the

structure of buildings, and to what extent the dependence of the structure upon such timber as it may be necessary to use, can be lessened, and in what manner the timber required in the structure may be disposed and associated to render it in the smallest degree susceptible of fire and liable to burn. Nor does it seem inconsistent with the right of every individual to devise and arrange for convenience and economy in the erection of buildings, that he should be required so to dispose and so to use timber that it may not become a source of danger to the future occupier of the buildings in which it may be employed, or to the public at large. The use of no building in a town can so completely seclude it, that the public shall not have an interest in requiring that it be made in as small a degree as possible liable to burn as may be consistent with a due regard to convenience and economy, and as wholly incapable as possible of communicating fire to other buildings or matters liable to damage from fire. The public have the same right, interest, and duty, indeed, in guarding the passive or helpless inmates of a family from the sordidness, recklessness, or stupidity of the head of the family, or of any member of it who may be the means of setting a dwelling-house on fire, as in guarding those who are not domesticated within

its precincts from any danger that may arise from casualty to the building from the same cause; and it seems, therefore, to be as proper to impose, on the part of the public, rules which shall have the effect of checking the susceptibility of buildings to fire, as to dictate the mode and insist upon the use of means to prevent fire from extending from one building to another.

Fire-escapes are useful, because, unhappily, houses are built so susceptible of fire that, if an accident happens, escape by the stairs and doors is precluded through the rapid progress which fire commonly makes in a house; but it would surely be better to render fire-escapes unnecessary by rendering houses safer in the event of fire, for most people can walk up and down stairs with more confidence, and certainly with less danger, than up and down ladders to or from their bed-room windows, even if it be supposed that such ladders are always present and ready for use.

The dangers accruing in the use of buildings from defective drainage and ventilation are here designated indirect, in contradistinction to the direct dangers already referred to, and because they act upon health and vigour by the air we breathe, and not by direct action upon the body.

Indirect dangers in the use of buildings arise from two distinct causes, which, however, act together when both exist, and each cause tends to increase the dangerous effects of the other. One is, the imperfect removal from buildings, or the removal in an inefficient or incomplete manner, of excreta, and of certain animal and vegetable refuse, which, as they ferment or become decomposed, throw off gases deleterious, if not dangerous, and, in any case, unfit to be inhaled by human beings. The other cause of danger is the retention of the same body of air within buildings, and the necessity imposed thereby upon the inmates of inhaling that which has already passed through the lungs, or which has been employed in the support of combustion, and become deprived thereby of the vital quality, and rendered unfit, therefore, for the purposes of life.

In buildings used as dwellings, these causes are commonly found to co-exist; and if the former of them is not present in buildings used for public congregation to the same extent as in dwelling-houses, the intensity of the latter is very frequently such as to render the air of the chapel, the concert-room, or the theatre, more noxious than that of the dwelling-house.

The defective ventilation of any building occu-

pied for the purposes of life, necessarily involves a deficiency of pure air in the building. The requisite focal fires in buildings compel the access of air, and tend thereby to promote ventilation ; but in the absence of proper channels for supplying them with fresh air, they are as apt to derive air from a foul as from a pure source ;—down the sooty flues of chimneys in which there may be no fires, or in which the fire may be weak, creating what is familiarly known as a smoky chimney, or up from the drains, which are then charged with giving a false alarm of rain ;—since every endeavour is made to prevent the cold draught which the fires would establish about the sashes and doors, and through the floors of the rooms, in which fires are used.

Even in the absence of fire, or where the fires are few and weak, the foul air generated in the drains will pass up into the house by the inlets for the liquids, or matters in a liquid state, intended to pass off by them ; the heat of the excreta and of the waste water after washing and cooking, inducing the evolution of light and expansible gases, which rise and add to the foulness and to the deleterious character of the oft-respired and pent-up air of unventilated apartments. If the inlets to the drains be trapped, and the foul air is prevented by the traps from rising within the build-

ing, it rises through the gully-gratings before the doors or under the windows, and deteriorates the atmosphere of the locality.

If, however, the case—the too common case—be taken, of the easement, as it regards the grosser matters, being so defective that there are no sub-drains and sewers for carrying such matters away, they remain in and about the buildings, and exhibit the danger arising from defective drainage in the coarsest form. It seems certain at the same time, that the existence of drains to houses, and of sewers into which the drains may empty themselves, gives no assurance of the wholesomeness of the buildings as dwellings; something more than the mere drain is required to that effect. Nor is it to be concluded too hastily that the soil-drain is in every respect better than the coarser-looking arrangements which it gives the means of superseding. When the subsoil is dry sand or gravel, and privies are made over cesspools which are dry-stained to allow the fluids to escape into the soil, the solid excreta are alone retained of the offensive matters, and as the gases which these throw off are heavy, they rest harmlessly until the emptying takes place, when the nightman, certainly, must beware, or he dies. If, however, excreta be made to pass directly into drains with the waste hot water of a house, the effect above described

takes place, and the poison which sleeps in the cesspool, being evolved and expanded, is kept in constant activity. Nor, again, are the ash-pit and middenstead of the north of England to be hurriedly abolished in favour of either cesspool or unventilated drain. The ash-pit is a filthy adjunct to a dwelling-house, but inasmuch as it receives cinders and ashes as well as excreta and vegetable and animal refuse, the antiseptic properties of the ash and cinder prevent the ash-pit from becoming either more offensive to smell or more noxious to health than the combined cesspool and dust-bin of the south, and less so, perhaps, than the unventilated house drain.

Thirdly :—As to the dangers arising from the employment of buildings for purposes which are themselves dangerous.

This class of dangers is properly a matter of police, and not of the regulation of buildings as such.

The inconveniences tending to obstruction and discomfort which buildings may be said to occasion, are of two kinds :—

- 1st. By intruding upon the public way by themselves or by any projection from them.

2nd. As it regards the uses for which they may be employed.

And, Firstly, as it regards the public way by the intrusion of buildings upon or towards it, so as to occasion obstruction.

It will be found in most towns that the labouring population is lodged in narrow courts and alleys, and that any new streets formed for the accommodation of that class of the community are made as narrow as they can be made consistently with the object of inducing people to resort to them as occupiers of the houses that may be built ; whilst the suburbs of modern towns are generally formed in the first instance by the extension of the principal lines of streets upon the roads leading into and out of the town, and the erection of houses and other buildings fronting to such extended streets and roads, but set back to some distance from them to tempt as occupiers those classes of the population who are not bound by their occupation to their places of business. Upon the gradual enlargement of a town the suburbs become absorbed, and the occupiers of the houses which had been set back from the roads and streets move off to a greater distance, and to houses similarly disposed in that respect. The attempt then becomes universal to occupy

the fore-courts and gardens of the houses so abandoned, with buildings, generally as projections before the original erections, and mostly for the purposes of shops.

But shops are made to draw customers, and consequently a road and its footways which may have been of ample width for the purposes of thorough traffic and to and from a series of dwelling-houses, will seldom be so when the houses cease to be mere dwelling-houses, but are turned into shops, or have shops added to them. Any such conversion ought, therefore, to be always attended by an enlargement, by widening, of the space for thoroughfare; that is to say, of the road and of the footways; for if it be not so, not only may the additions made to a town by the absorption of its suburbs, tend to exclude light and air, by narrowing the accesses for it, but be made accessory to choking up the ways into and out of the town. Every large town in England will furnish examples of this process of the absorption of the suburbs and of the bringing forward of buildings as indicated; and it is a process constantly going on, to the inconvenience of the inhabitants generally of every such town, and to the real advantage of none. London suffers from it more perhaps than any other large town, because of its greater magnitude; and ex-

amples of the evil may be found in it on every side and in every part.

The Metropolitan Buildings Act has done something towards staying this plague also in London, but its provisions in that respect are, nevertheless, so defective, that it is far from affording a remedy, whilst to some extent it defeats its own objects by being, in some of its provisions, both too loose and too stringent; it uses language capable of being misapplied and misunderstood, and it provides no means for modifying its effect in cases of unnecessary severity, when the language is precise. The Act referred to deals with projections before buildings, but it is not thought to prohibit the erection of buildings in places corresponding with those upon which projections before buildings may not be made. The Act says, with regard to projections of any kind, "Such projections must neither be built with nor be added to any building, on any part of an external wall, so as to extend beyond the general line," &c. Some of the District Surveyors acting in the administration of this Act, consent not to understand "*on*" in this rule, to be intended in the sense of *before*, and allow buildings to be erected before the general line, so that they do not touch the buildings before which they are erected; others of them hold a general line to be established by the existence of a projection before one of a dozen or of a score of houses; whilst some have allowed

houses to be built before the general line, so that there were no house immediately behind them.

The inconvenience takes another form when there is a sunk area instead of a fore-court, and when a statutable provision, the practice of the neighbourhood, or some local regulation, prevents the site from being occupied wholly with an addition to the building. A shop-front of greater or less projection is made before the house, and the space over the area is nominally added to the footway, the space so added, however, being covered, not with safe and convenient paving, but with iron gratings, or with hinged flaps. So far as the hinged flap is concerned, it is dangerous as well as inconvenient, inasmuch as it is necessarily made of a slight and slippery substance, and liable when shut either to throw down, or to fall down under, whoever may tread upon it, and, when open, to lead to even more serious casualties. The iron grating also is far from being safe to walk over, especially for children, whilst the indecency, as it regards females, of laying open gratings over areas under the public footways is so great, that nothing but habit can have blinded the eyes and blunted the feelings of the public to the shameful practice. Shopkeepers must, indeed, be something more than blind and dull,

who erect costly shop-fronts to display their goods in the most tempting guise, and then spread open gratings before the windows to deter modest women from approaching them.

The protrusion of shop-fronts and their accessories beyond the walls of the houses, so as to encroach upon the public way, is a great public inconvenience; and inasmuch as the encroachment upon the public ways becomes necessary,—if it be a necessity,—only because the house from which the shop-front is protruded has been built close up to the public way, there cannot be the slightest injustice in prohibiting such projections, as well as any and every other kind of projection, from being made upon or so as to extend over the public way.

The Metropolitan Buildings Act directs that in cases of original building, and of rebuilding, the walls must be set back, “so that all “projections therefrom, and also all steps, “cellar-doors [flaps], and area enclosures, “shall only overhang or occupy the ground of “the owner of the building, without over- “hanging or encroaching upon any public “way;” and if effect were given to this rule according to its obvious meaning, time—though a very long time certainly—would establish a right state of things in that respect in London. The provision of the Legislature is not carried out, however, according to the directions it

contains. A notion prevails that, notwithstanding the express words, the direction is not intended to apply to the rebuilding of buildings existing when the Act came into operation, and consequently the Act is in that respect wholly inoperative. It is not a little strange, however, that instances are to be found in London, in which the course which the Metropolitan Buildings Act directs to be taken, under certain circumstances, had been taken, and the above-quoted directions prospectively fulfilled under circumstances of the kind contemplated. A well-marked instance occurs on the south side of the Poultry, where two houses, one of which is occupied by the well-known cutlers, Messrs. Pepys, having been rebuilt, were set back, to the manifest advantage of the public way, and with no disadvantage whatever to the shops. Messrs. Praed and Co.'s banking-house in Fleet Street, on the north side, and Messrs. Hoare's, on the south side, are other similar examples of buildings set back, as if to show, with the examples in the Poultry, what a good effect may be produced thereby as it regards the convenience of the public, and with how little disadvantage to the individual proprietor.

Unfortunately for country towns bad practices in London are imposed upon them by the authority of the example of the metropolis, and abuse upon abuse having led in London to the recognised encroachment of the shop-front upon

the public way, every country tradesman deems himself at liberty to form, and corporations and commissioners allow the formation of, a bulk, so that it be for a shop-front, outside of, and beyond the walls of the houses, to narrow the footway and form an obstruction to the public, with no other imaginable justification than that it is done in London.

The history of the shop-front is somewhat curious.

The Act for rebuilding the City of London after the great fire (18 and 19 Car. II.) is supposed to have been drawn by Sir Christopher Wren, but upon what the supposition is based does not appear, unless it be the internal evidence of sound practical knowledge and general good sense which pervade the statute. This Act, after requiring that "the outsides of all buildings in and about the said city be henceforth made of brick or of stone, or of brick and stone together," with certain exceptions in that respect as to brestsummers "*for conveyancy of shops*," directs that "no trap-doors or open grates be in anywise suffered to be made into any cellar or warehouse without the foundations of the front, but that all lights to be made into any of them be henceforth made upright, and not otherwise; and that no bulks, jetties, windows, posts, or anything of like sort, shall be made or erected in any streets, lanes, or by-lanes, to extend beyond the ancient foundations, nor that any house

“ be set further into the street than the ancient
“ foundations, saving only that in the high and
“ principal streets it shall be lawful for the in-
“ habitants to suffer their stall-boards (when
“ their shop-windows are set open) to turn
“ over and extend eleven inches and no more
“ from the foundation of their houses into the
“ street, for the better conveniency of their
“ shop-windows :” that is to say, the shop
window-board might be hinged as a flap and
be turned out when the shop-window was
open, as a stall, upon which to expose goods for
sale, and, of course, to be turned in when the
window was shut.

The next time the stall-board makes its appear-
ance in a Building Act, the permitted turn-
over flap had become a fixed projecting base to
the bayed or bowed and fixed shop-window,
enclosing the space allowed by law to the
hinged flap while the shop was open only ;
and the pent-house shelter for the public,
which the Act of Charles II. had required to
be made over the paved footways before the
houses, had become the cornice to the protruded
shop-front.

Thus a “ bulk ” with “ windows ” in it came to be
extended “ beyond the ancient foundations,”
contrary to Sir Christopher’s wholesome pro-
vision as to such things ; and after time had
honoured the abuse by winking at it for two or
three generations, the 12 Geo. III. c. 73, made
a bow-window or other projection “ for the
“ convenience of a shop or shops ” an exception
to its general prohibition of “ bow-windows or

“ other projections against or before any house
“ or other building situate in any public street,
“ lane, or place ;” limiting the protrusion of the
datum—the stall-board—to five inches in lanes
and narrow streets, and to ten inches in any
street being more than 32 feet wide. The
prohibition and exception as to projections
and protruded shop-fronts are continued in
the 14 Geo. III. c. 78, now known in London
as the Old Building Act, more in detail than
in the earlier Act, and with an alteration of 32
feet into 30 feet as the width of a street which
would admit the greater protrusion of shop-
front ; and the prohibition of the Old Building
Act as to projections, with the same exception
as to shop-fronts, re-appears in the recent and
now existing Metropolitan Buildings Act.

Hence it appears that an ill-judged concession to
the shop-keeping citizens in the time of
Charles II. has had the effect of making
Cheapside, Ludgate Street, Fleet Street, and
the Strand in the older parts, and indeed all
the old shop-streets and lanes throughout Lon-
don, from one to two feet narrower than they
would have been if the concession as to the
turn-over stall-board had not been made ; as
the shop-front excrescence would, in all prob-
ability, otherwise, never have been devised.

Porches and other such like adjuncts to build-
ings would seem to be projections that ought not
to be denied to a house ; but porches are capable
of becoming nuisances, as obstructions to the

public way, or to light, air, and view, and ought, when they are made, to be made under restraint, to the same extent perhaps to which shop projections ought to be restrained.

Walls and other close bodies, as fences between the fore-courts of houses, are also capable of becoming obstructions injurious to the public, by preventing the due circulation of the air, and by intercepting the rays of the sun, and ought to be limited as to height, according to the circumstances of the situation.

All the foregoing considerations have regard to streets, taking the term street in its largest sense, of any public way within and about a town, and as existing and devoted to the public use in connection with whatever buildings may have been, or may be erected, fronting to, or to which access is obtained by or through them.

But there is an important element of the subject generally that has not yet been considered, important alike to the comfort and convenience of the public, in the use of the public ways, and incidentally to the public health as affecting general ventilation. This is the arrangement and disposition of the streets in adding to a town. Owners of extensive estates, such as the Duke of Bedford, the Marquis of Westminster, Colonel

Walpole Eyre, and many others, in London, have within their own hands, when laying out their lands for building, the means of protecting their own proper interests, and of subserving the convenience of the public. But in such cases, even, it would be beneficial to all parties if there were a public authority, competent to impose upon the several owners of adjoining lands, and of lands adjoining parts of a town already built upon, such arrangements as would make the future streets most convenient to all, without inflicting injury upon any. If this be desirable, as it regards large estates, it is much more so when small ones are affected, and to these the observation applies with full force. A landowner, laying out his land anew for building, has the benefit of all existing public streets and roads up to his land, and for these he has paid nothing, and he ought to be compelled, in return, to open his roads as a means of public access to whatever may lie beyond, whether it be town or open country, upon such reasonable conditions as the circumstances may require in each particular case.

These considerations become of even greater importance when the subject of drainage is considered in connection with the ventilation and the convenient use of streets. Sewers, to be convenient, must be led along the courses of streets ;

and consequently streets should be laid out, connected and extended with reference to the proper courses for the sewers, as well as for the streets as ways of communication to and about the houses. Streets, sewers and drains, together with the contingent services of water and gas, and all other matters affecting the public health, comfort, and safety, or any of them, ought to be combined in one system, and be in every town under the conservancy of the same, and that a sufficient, authority to regulate them for the public good.

Secondly :—As to inconveniences in respect of the uses for which buildings may be employed.

This class of inconveniences is perhaps a more proper subject of police regulation than of regulation as it regards the buildings which may be employed for purposes capable of annoyance or offence. The building may be the same, whether it be used as a cooking-shop or as a tallow-melting shop; whilst one of the purposes, although capable, under certain circumstances, of annoyance, cannot be treated as offensive, or as tending to become a nuisance; and the other is of a kind to be prohibited, without question, in almost every inhabited locality. At the same time it should be understood that the offensiveness of even a tallow-melting shop is not a

necessary condition of the process employed ; for by judicious arrangements, and the application of proper means in and to the building in which it may be carried on, tallow-melting can be rendered as free from offence as the ordinary operations of cooking.

And so indeed with many other trades and manufactures, which are deemed to be, and are dealt with as nuisances, because of offensive smells arising from their processes ; for there are but few trades or manufactures of an offensive character carried on within enclosed buildings, of which the offence may not be so abated as to render them no longer improper to be carried on within a town.

In connection with the regulation of buildings in towns for the protection of the public, there ought to be provided protection for private persons against wrongs which are easily inflicted, and redress of which by ordinary process of law is difficult and expensive, since the temptation to commit such wrongs is greater in towns, and particularly in large towns, than in country parts and places.

A right to build up against or before newly made windows as lights, is altogether insufficient as a protection against encroaching neighbours in and about towns, and protection by statute

against such encroachments is, indeed, but simple justice to private persons, if for the public protection rules are imposed upon them to prevent communication of fire from house to house. Injuries to the light and air of the buildings of others are also much better provided against by statute, and all questions of that nature are better disposed of under rules imposed by statute and administered summarily, than by the ordinary course of law.

The Metropolitan Buildings Act provides that *projections* may not be made from the walls of buildings so as to obstruct the light and air, or be otherwise injurious to the owners or occupiers of adjoining buildings. Under this provision, the owner of a building required the Official Referees to inquire into the proceedings of his next neighbour on one side, who was about to erect some buildings in such manner as to affect the light and air of the building belonging to the requisitionist. It was found upon inquiry, that the case was not within the statute, and consequently not within the jurisdiction of the Official Referees, the works complained of being *buildings* about to be rebuilt of greater extent, and of greater height than before, and not projections added to a building. Failing of a decision by the Official Referees under the provisions of the Metropolitan Buildings Act, the requisitionist applied to the Court of Chancery to grant

an Injunction to restrain the intending builder from proceeding with his works because of the apprehended injury to his light and air. The Court granted an Injunction upon conditions, and directed that an action should be tried at law. An action was brought accordingly, and upon coming on for trial, was referred, by the compulsion which the superior courts use in such cases, to an architect in private practice, who eventually awarded in favour of the intending builder. It so happens that the decision of the Official Referees, who had, as they were required to do, investigated the circumstances of the case, would have been precisely the same as that which the private arbitrator made as the referee of the superior Court. If the case had been within the jurisdiction of the Official Referees, the same decision would have been made in ten days or a fortnight from the making of the requisition, and would have cost from five to ten pounds. As it was, the builder was stopped for six or eight months by the proceedings of his neighbour, and the costs of the proceedings amounted to more than 1500*l.*, besides the loss which the builder incurred by this unnecessary delay of his works for the period stated.

It is not intended, however, to discuss in this place the political question of the extent to which the State ought to interfere in matters of the kind in question, or the means by which effect may be given to wholesome regulations as to such matters,

but simply to set forth the practice which may be necessary to produce and to secure certain effects, the effects being by common consent desirable. It is for the public by the Legislature to determine whether, and to what extent, it shall be required to submit to rules which may embody such practice ;—whether, indeed, a process which is in effect educational, shall be submitted to, not alone for the sake of the positive good that may result from it, but also for preventing the evils which arise from ignorance rather than otherwise. But the public are still haunted by fears of the long-laid ghosts of a defunct tyranny, and are in many respects slaves of the school-boy belief that because the purposes of education require some degree of restraint, all interference with the uninformed will involves an infringement of liberty. So long, however, as it is deemed no infraction of the liberty of the subject to incarcerate the unintentional homicide who, in building a wall, so works that the wall falls down and kills a man, it cannot be wisely thought an undue interference with rational liberty to require that walls be built and works carried on only in such manner and under such control as to be free from liability to produce any such casualty ;—so long as it is not an undue interference with the rights of the subject to prevent the poor huckster of small

wares from obstructing the public way by setting up a stall upon its outer border, it will not be so to prevent the established shopkeeper from intruding his stall-board upon its inner margin ; —so long as it is consistent with the liberty of the subject to compel the inhabitants of towns to pay rates for making and maintaining sewers into which their houses are not and cannot be drained, and so long as the sick poor must be relieved and cured at the public expense, it cannot surely be deemed an unnecessary interference with the liberty of the subject to take steps for preserving to the inhabitants of towns the use of what they pay for, nor a tyrannical exercise of the power of the State to require that the labouring population, —of whom are the poor,—shall not be disabled from helping themselves by the continued existence in and about their dwellings of any preventible causes of danger or of disease. Education leads the man to impose upon himself restraints more severe than those to which, as a child, he was compelled to submit ; and the practice which is herein indicated or otherwise set forth as proper to be adopted, and as a rule to be imposed, is no other than a community rightly taught would impose upon itself.

A G U I D E,

§c. §c.

IN treating of the Regulation of Buildings, it may be requisite to premise in what sense and to what effect the term Building is used and applied.

It is hardly necessary, perhaps, to say that the term is always employed in its substantive sense when regulation is implied; but it must be explained that, when nothing to the contrary appears in the context, the term Building is intended to include all structures and erections of brickwork, masonry, and carpentry, or of any one or more of those arts, or of any constructive imitations of, or substitutes for them, or any of them. A wall of concrete may thus, for the purposes of the definition, be taken to be a work of masonry, and a floor or a roof of iron, whether the metal be wrought or cast, may be taken to be a work of carpentry, and so with many other things.

The term Building thus understood becomes a convenient generic term, applicable alike to the

palace and to the hovel, to the almost horizontally built sewer, and to the vertically erected furnace chimney-shaft.

It is to be understood also that by the Regulation of Buildings is intended as well the placing of buildings with regard to the public way as to one another, and as well the safety of buildings in their relation to the health of those who occupy or otherwise use them, as the safety, under any circumstances, of their material structure, and thus to include all matters connected with, and incident to, buildings, as well as the buildings themselves.

Many of the objects to be attained by the proper regulation of buildings are obtained by the same means. If one building be separated from another,—the buildings being taken to be dwelling-houses or such like buildings,—by a space sufficiently wide to render the one secure against communication of fire from the other, whether it be by the doors and windows or other openings, or by the materials of which the enclosures or coverings may be composed, such buildings will be for the most part sufficiently apart to allow of a due circulation of air about them, so far as they can affect one another in that respect; and if a building be built safely in its structure as it

regards those persons who may occupy or otherwise use it,—and if it be free from liability to take fire and to burn,—and be so arranged and disposed as to be wholesome for habitation,—there can be no danger of such a building falling upon the neighbours or upon casual passers-by—the public,—and it will be tolerably free from liability to communicate either fire or fever to the neighbourhood: and, conversely, open space behind buildings for the purposes of ventilation will be secured without prescribing any specific area to be left to fulfil that object, if openings for doors and windows might not be made in the walls of buildings standing so near to other buildings, or to adjoining property, that one building could not communicate fire to another by their respective doors and windows. The same may be said, indeed, of streets and other open spaces before buildings. If access of air and of the sun's rays be provided for by sufficient width,—having regard to the height of the buildings fronting to such spaces,—the buildings will be far enough apart to render them tolerably safe from one another as it regards communication of fire; and in like manner restrictions for the protection of next neighbours will protect the public generally. Raising party-fences to an undue height,—extending buildings or parts of buildings before the

general line, and many other things connected with undue height or projection, and some with both, require to be regulated and controlled, alike for the public good and for the protection of next neighbours, and the same amount of restraint will generally be sufficient to fulfil both requisites.

THE PLACING OF BUILDINGS WITH REFERENCE TO ONE ANOTHER.

IF buildings such as houses and warehouses of ordinary construction, that is to say, with outer or enclosing walls of brick or of stone, and with floors, roofs, internal partitions, stairs and other fittings of wood, the walls having openings as doors and windows in them, be placed at less distance from one another than the height of the buildings from the ground, and without any intervening body, such as a solid wall, to intercept the radiation of heat and flame and burning embers, they are capable of communicating fire to one another, in the event of fire occurring in opposite buildings; and in the case of lofty warehouses filled with goods of an inflammable nature, fire is communicable from building to building with but slight assistance from the wind, at even a much greater distance than that indicated. Generally, however, the danger is as the height of the building on fire, whilst the greater the height of the building, the greater the difficulty of controlling the fire and checking its

progress, even when the usual means are present or become available in time to render any useful service. Other means besides inconvenient distance apart from one another may be adopted for lofty warehouses; but as it regards ordinary dwelling-houses in the streets of a town, and particularly houses used as shops and having wooden shop-fronts, no such buildings can be considered safe from one another in the event of fire in opposite buildings, in the absence of the extraneous aid of firemen with engines and a supply of water, if the houses are at less distance apart than a space equal to their own height.

If this rule be applied to the rear fronts of houses, and to the flanks of houses laterally detached, where party-fence walls are commonly used to separate adjoining premises, the liability of the opposite houses to receive fire from one another is lessened in proportion to the height of any such wall, and the distance from house to house may be safely lessened by a space equal to the height of the wall.

When, upon a flank or on a return of a building, windows occur as a matter of necessity or of great convenience, and the distance from opposite windows is less than that which would arise from the application of the above-stated rule, the windows should be so arranged in the opposed parts

as not to be opposite, window to window, but rather window to pier of the opposite walls respectively.

The circulation of air about buildings will be sufficiently well provided for by the application of the above-stated rule, and the circulation will be more or less perfect as the rays of the sun are enabled to penetrate the spaces between the buildings, or are intercepted in their way to it. The access of the sun's rays will depend in a considerable degree, of course, upon the range or direction the street or other frontage-way may take, but as a general rule applicable to all aspects in the high parallels of latitude within which England is situated—and it is to England principally, and to London especially, that these observations are intended to apply—the rays of the sun are not allowed to descend so low, and to act so long, about and upon the buildings as the wholesome ventilation of the streets requires, if the buildings are separated by a less space than a space equal to their own height above the surface of the street in any case.

But however desirable it may be to secure the application of such a rule as the general rule above stated in all cases, it is only in the case of streets newly formed, or of existing streets extended into new districts, that any such rule can

be made peremptory. For the most part buildings must, as a matter of economy, be rebuilt as they have been heretofore upon the same sites, and no desire or endeavour to improve by widening the streets of a town should be checked or restrained by rules which are addressed to other circumstances.

It is hardly necessary perhaps to say anything in this place of the inconvenience arising from excessive width of way in the streets of a town, as any objection on that score is not as to the breadth between opposite buildings, but that excessive width of road leads to random driving, and that an excessively wide road cannot be well lighted over at night from the opposite sides.

Portland Place, in London, presents an example of excessive width of carriage-road, where the inconveniences alluded to are felt, whilst the Boulevards of Paris, which are almost throughout of greater width from front to front of the buildings, are free from such inconveniences, and the pedestrian public are better accommodated.

ARRANGEMENT OF STREETS IN TOWNS.

THE streets into and out of a town, leading through it, or radiating from its centre and joining on to great roads, are almost of necessity its principal thoroughfares, and should be laid out,—when laid out originally,—and extended, with reference to their convenience as streets rather than with reference to the height of the buildings fronting or intended to front to them, so that the width arising from the rule in that respect be the minimum. Such, in London, are Piccadilly to the Great Western or Bath road, Oxford Street to the Oxford and Edgeware roads, Borough High-Street to the Kent and Surrey roads, Aldgate Street to the Essex roads, and High Street, Islington, as the centre of many great radiating thoroughfares, to the Great North Road. All the streets that lead to and from these great outlets are themselves great lines of local traffic and of retail trade; for retail trade generally establishes itself in and upon the greatest thoroughfares, and this kind of trade requires that there be room for carriages to stand in the

street before the shops ; and this should be without interfering with the traffic along the street.*

Cross streets are less to be regarded for the space required for traffic, but rather with reference to the sufficient distance apart from front to front of the buildings fronting to them, for

* “ Carriage-roads should always be wide enough for three
“ carriages, at the least, to travel upon the same transverse
“ line at the same time, that fast carriages may not be unnecessarily impeded by slow ones, and that the road may be
“ open even if two carriages happen to be stopped on opposite
“ sides of the road at the same time. In the carriage-ways
“ of streets within towns where there may be dwelling-houses,
“ shop-houses, or warehouses, on both sides, before all of
“ which carriages must be frequently standing, and on both
“ sides at the same time, there ought, for the reason before
“ mentioned, to be width between the standing carriages for
“ three, at the least, to move abreast ; and where the thoroughfare is great, even more is width greatly desirable. Light
“ carriages cannot be required to stand in less than six feet,
“ nor can they be driven with freedom and safety in less than
“ eight feet ; heavy carts and waggons should have eight
“ feet to stand in, and ten feet when in motion ; so that no
“ public road of mixed traffic ought to be less than twenty-
“ eight feet wide in the carriage way, and no street that is a
“ carriage thoroughfare, and built, or liable to be built, on
“ both sides, should be less than forty-two feet wide in the
“ carriage way : much used thoroughfares, as all streets
“ leading to and from a free bridge within a town must be,
“ because of the concentration of traffic from many streets
“ to that one street, ought, of course, to be still wider.”—
[From the ‘ Practical Treatise on Bridge Building,’ by the
Author, forming part of the Theory, Practice, and Architecture of Bridges, published by Mr. Weale in 1842.]

due ventilation. These, however, become shop-streets, and too commonly the first essential, as it regards the public accommodation in case of such conversion, is wholly disregarded. If there be a space, however narrow, between a house and the street, it is commonly absorbed for the purposes of the shop, whenever the house is converted to a shop; whereas the process ought to be reversed, and such space, in whole or in part, should be thrown into the street to accommodate the greater traffic the shop will induce.

THE SAFE STRUCTURE OF BUILDINGS.

ALTHOUGH buildings of almost all kinds, and for almost all purposes, may be built safely, as it regards their structure, of timber, the susceptibility of this most useful material of fire, and the rapidity with which it burns when placed in the favourable circumstances to that effect which its disposition in an erected building such as a dwelling-house requires, have led to its prohibition for the purposes of the main enclosures of such buildings, and, indeed, of buildings generally, in London and in some of our large provincial towns. It is possible, nevertheless, so to protect timber employed in the enclosures and for the internal partitions and floors of buildings as to render mere dwelling-houses practically fire-proof—certainly more so than most brick-enclosed buildings are made at the present time in this country, where the internal partitions are of timber, wood-lathed and plastered, and the floors and stairs are of wood in like manner wood-lathed and plastered. Whilst, however, timber may be so protected as to prevent it from burning

readily, even if it take fire ; and although economy may be best consulted, and safety of structure certainly secured, by the use of timber for the frame or skeleton of a building, brick and stone are the least objectionable substances with which to form the main structure of buildings, as they are, indeed, in most other respects, the best adapted for that purpose. But one important principle which ought to be always had in view in the employment of these materials in ordinary buildings is for the most part wholly lost sight of, if indeed it be at all recognised in the modern practice of building. Brick or stone, or brick and stone together, with mortar as a setting material—not only as a cement for the purpose of sticking the materials together, but as a means of rendering excessive labour upon the beds and joints of stones unnecessary, and to make up for the casual unevenness of the beds of bricks, and to adapt them to the various forms required to be produced—being capable of producing any and almost every kind of structural erection required in building, without permanent aid from any other materials, are best employed when they are employed in such manner as to be free from dependence upon other and less trustworthy materials. The most perfect erections as buildings are those in the composition of which this

principle has been understood and applied, and in the execution of which it has been fairly practised. To save in the quality or quantity, or in both, of materials, and to economize labour, or to satisfy the judgment of ignorant constructors, brick and stone walls are too commonly made to depend wholly or in great part upon timber in bond and in plates ; and as timber takes its place for such purposes most frequently in situations where its bad tendencies are most mischievous, and in such manner as to bring its objectionable qualities into operation almost of necessity, the brick and stone walls of most modern erected buildings, such as houses, in our English towns, are rendered highly inflammable, and are much exposed to early decay, and liable thereby to become dangerous, even if they escape becoming so from access of fire to the timber. If adventitious aid be given to brick or stone walls by foreign materials, the materials ought to be at the least harmless, and the aid superfluous. Iron in bulk is a most improper substance to incorporate with walls, because of its great susceptibility of heat ; but iron used in thin laminæ, as hoop-iron laid in walls in the bed-joints of the brick or stone, cannot be productive of any bad consequences to the structure, whilst it affords the means of tying together walls which, because of

recesses and voids, whether for doors and windows or as flues, may be slighter or less solid than they ought to be.

As bricks are commonly made of the same form, and come to the hands of the builder practically of the same size, and as bricks, even where stone is principally used, are requisite, if not essential, for many of the purposes of dwelling-houses and such like buildings, the thicknesses of walls are conveniently determined to be as they can be produced in brickwork, that is to say, of so many bricks or half-bricks. Practically, too, brick walls take a middle place among walls of brick and stone together, and walls wholly of stone. Some kinds of stone are harder and more durable than bricks are commonly produced, whilst some kinds are softer and less adapted to withstand the action of the weather than bricks of average quality are found to be. But bricks come to the hands of the workman regular and unvarying in form, and that a form the best adapted for the arrangement in the construction of a wall which, under the designation of bond, gives such a degree of consistency to the structure that a weight placed upon the top of a well bonded wall in any place is carried by the wall in every part throughout its whole thickness, and throughout a greater or less proportion of the length according to the

height of the wall, and so in degree as to a weight imposed upon the wall at any intermediate level.

Bond in brickwork is most conveniently and most effectively formed and maintained by disposing the bricks in their courses either endwise and lengthwise (technically, header and stretcher), alternately brick and brick, or course and course; that is to say, that the bricks in every course should be laid alternate header and stretcher, or that the courses should consist of all headers and all stretchers alternately. The former arrangement—alternate header and stretcher in the same and in every course—is known in this country as Flemish bond; and the latter—alternate courses of header and stretcher—is distinguished by the term English bond. Neat work in face can be produced more easily with Flemish bond, but English bond has the reputation of being the best bond structurally.*

* Why the two arrangements described above should be distinguished by the names they bear is a matter of uncertainty; at least, it is unknown to the author, who supposed, in common with most other people with whom he had conversed upon the subject, that alternate header and stretcher in the same course was the practice in Flanders, and generally in the neighbouring countries on the Continent, whilst the term English bond seemed to imply that the arrangement which bears that designation is peculiar to England. A visit made a few years ago to the countries where Flemish bond ought most to abound, if the name be properly applied, enabled the author to observe what had never, to his knowledge, been re-

The arrangement of alternate header and stretcher in the same course is that which most prevails in building walls with stone; or rather, the bonding of stone walls is best effected by that kind of arrangement, whilst, indeed, alternate courses of headers and stretchers in a stone wall would be both unsightly and absurd.

Stone, on the other hand, comes to the workman formless, that is to say, without regular form; and with skill on the part of the workman to select, dispose, and arrange the materials, safe and good erections may be produced of rubble; for although the greater or less thickness of which walls may be built of rubble with safety will depend in a great degree upon the proper consistence and power of induration of the mortar, it is more to be considered with regard to the

marked by any person who had published his remarks, and what was quite unknown to every one to whom he has stated, since his return, what he had observed. At Rotterdam and at the Hague, at Antwerp, at Brussels and at Liege, at Cologne, at Mayence, and at Frankfort, and again throughout the north-eastern parts of France, brick walls are built according to the arrangement distinguished in England as English bond; and Flemish bond is unknown—at least no single example of it fell under the author's observation in any of the towns and countries indicated, although his attention was called to the subject by the quay walls at Rotterdam before he set foot on shore.

skill of the workman in bedding and bonding the shapeless stones. Under any circumstances, however, a wall so composed may not safely be charged with heavy weights, nor indeed with its own weight, nor be exposed to the vibrating action of floors, until the mortar shall have indurated sufficiently to withstand the pressure of the weight, and hold the work together when the floors are shaken ; whereas a wall of brickwork is secure by the horizontal bedding of the bricks, and by the effect of the transverse bond which the alternation of header and stretcher almost necessarily produces. Stone, again, may be dressed to any and every shape, and so as to mould it to any form and to every variety of construction with the smallest possible quantity of mortar or other setting material. From blocks with rough hammer-dressed parallel beds up to the most complete and perfectly wrought parallelipeds adapted to any arrangement of bond that may be best adapted to the form and disposition of the structure, and with combinations of rudely formed and perfectly formed pieces of stone, walls may be built of stone of greater strength than the best bricks can be made to yield, whilst stone walls are liable to be inferior in every respect to brick-built walls of the most ordinary quality.

Some combinations of the two kinds of materials have the effect, however, of making a better wall than could be produced by the main constituent in the form employed alone. A stone rubble or pebble-built wall is greatly improved by one or two bonding courses of brickwork at short intervals in height; and a brick wall is improved and adapted for a higher purpose by thorough courses, at intervals, of good stone, wrought to bed and joint truly, whilst on the other hand a wall substantially of stone rubble or pebble, and faced with brickwork, is essentially an unsound wall, as in like manner a brick wall faced with wrought stone is liable to be weaker than the brickwork would have been without the stone.

Having regard to the thicknesses of the walls of buildings, it is generally considered that these should be governed by the height of the structure, and there can be no doubt but that they should be so governed; but they ought not to be determined by that condition alone. Chimney-breasts built up with a wall, and extending to more than the thickness of the wall, make it in fact stronger in its transverse section, and justify less general thickness in the body of the wall, whilst window and other openings in a wall leave piers which ought to be of greater thickness than the mere height would require. But all returns, indeed,

whether as chimney-breasts or as cross walls, built and bonded with a wall, tend to render unnecessary the full thickness the height would require; whilst, as just intimated, the omission of portions of a wall for door and window openings should be compensated for by additional substance to the portions which remain.

Buildings separated from one another by the same wall as a party-wall, derive much structural benefit from the extension of the party-wall of its full thickness at least through, and beyond the outside faces of the fore and back front or other external walls; and it should be made imperative so to extend in all cases of building or rebuilding a party-wall, of which the external walls meeting it, and with which it ought to be united, are not built or rebuilt at the same time, so as to be coursed and bonded with it. The common practice upon the demolition of a party-wall is to take down the wall up to the inside faces only of the external walls, and in rebuilding, either to carry up the party-wall merely abutting upon those faces, and with little better than a straight joint, or at least with an imperfect connection by means of bond-timber and wooden plates; and hence it is that so many bulged and overhanging front walls are allowed to threaten danger in our streets; and because of this bad practice it is, too,

that fires do pass at times from one building into another through the party-wall, that is to say, it passes round the ends of the wall which has been built too short for its purpose. And it is the same in pulling down and rebuilding front walls ; the ends of the party-walls are commonly pulled down as if they were parts of the front walls, with the same defective result in the rebuilding.

Undue action upon walls, such as that arising from slight joists tailed into them, or that occasioned by the inclined timbers under galleries in churches, chapels, and theatres, requires that the walls be of greater thickness than their proper duty of bearing steady vertical pressure would require ; whilst it is almost inconceivable to what great heights brick walls may be built with safety, of the smallest thicknesses, if they are well built, and are exposed to no other action than direct vertical weight, or weight acting at right angles to the beds of the bricks, and in the line of the centre of the wall. When, indeed, such walls are to stand upon a sufficiently resisting foundation, and are well built, direct vertical weight without motion is a means of security to the walls so long as the weight is reasonably within the power of resistance of the materials to crushing pressure. The object to be looked at, therefore,—the walls being honestly built,—is to make the

weight to be imposed upon any wall act upon the solids of the wall vertically and steadily.

To this effect floors upon girders, or framed to strong trimmers, the girders or the trimmer-joists running into and bearing upon the piers or solids of the walls, are far preferable to what are termed single floors, of which every joist runs for itself into the walls. Girders, as the basis of, or to carry, floors, render plates in the walls wholly unnecessary, by depositing the weight in the right places, without requiring plates to carry it on from the weaker to the stronger places; and being of necessity stout and rigid, they form a fair tie and strut to the walls into which their bearing ends are tailed, and upon which they rest. Moreover, girders, being of infrequent recurrence, may be allowed to tail into party-walls without injuring their efficiency as a means of stopping fire, and so buildings of several stories may be rendered stiffer, or less liable to be acted upon by movement upon the floors within them, than when all the floors bear upon the same walls, and these the walls which are too commonly the most infirm.

Floors trimmed across voids in the walls which have to carry them, as almost all floors in dwelling-houses have to be trimmed before the fireplaces, and in most buildings about the well-holes for

the stairs, possess many of the advantages of the girder-borne floor ; but it requires more constructive skill and a better knowledge of carpentry to make a good trimmed floor than to make a floor upon girders. Whether girders or trimmer joists be employed, however, as a means of conveying the weight of floors to, and depositing it upon, the walls of a building in the safest manner, the bearing timbers ought to be placed upon pieces of stone as templates built into the walls, and be made to take a cog hold of the templates, so as to enable them to tie and stay the walls by means of the cogs.

It is by means of the girder bearing upon the solids of the walls, though with bad carpenters' work, or *carpentering* rather, that the French are able to carry up their soft stone rubble walls to heights that would frighten even a London builder, and that would certainly be unsafe if the walls were seamed with wooden plates, and shaken by floors of single joists ;* and it is by means of the

* The author, being at Paris in 1846, measured the thickness in the ground-floor story of a newly-built coursed-rubble party-wall, in the Rue de la Banque (the Gresham Street of Paris), and found it to be exactly 18 English inches in that part, whilst the total height of the wall was not less than 85 feet. The wall ran up of that same thickness through six stories, a height of not less than 65 feet, and was terminated by a gable of from 12 to 15 feet high, of the same kind of

solidity given to the floors by the girders, and the solid bearings which the girders obtain, that the floors are able to carry the dead weight of matter which renders them practically fireproof, as hereinafter described, in addition to the moving weights to which the floors of buildings are necessarily exposed in use.

We can, and do, frame floors most effectively by carpentry alone; whereas the French do the work in framing their floors so badly, that no important bearing is, or indeed may be, trusted by them to the framed joint—dog-nailed stirrup straps of iron being always brought in aid. But the common practice with us, who can and do frame floors well, is to use single or unframed floors, which carry the weight and the vibration to which floors are exposed into the walls, over voids as well as over solids; whilst, on the other hand, the French almost invariably frame their floors to or upon girders, by means of which the floors are brought to bear upon the solids of the walls. The walls are thus not only less exposed to vibratory action, but are both tied together and strutted apart with better effect by

structure; and there was besides a vaulted basement story, throughout which the wall might have been 20 inches thick, as other similar walls then in progress to neighbouring buildings proved to be.

the stout girders stiffened by joists, than by joists which themselves require some foreign aid to stiffen them. Moreover, single floors of joists, unless trimmed at frequent intervals, when, indeed, they may be termed half-framed, require, or are thought to require, plates of timber laid along the inside faces of outer walls and upon internal walls, and thus tend to the injury of the walls by introducing timber, that bane of brick and stone walls, into their structure, so as to render the timber a part of the structure. This defect is avoided by our neighbours, who exclude all timber, except the bearing ends of girders, from their walls, and who use framed floors.

When the walls of a building, such as a dwelling-house, have reached their full height, the wall-plate comes into use legitimately, to cope the walls, in fact, as well as to form a curb as a base upon which to place the roof, which should deposit its weight, nevertheless, by means of its tiebeams upon the plates over the solids of the walls below, and which should oversail so as to cover and effectually shelter from the weather the enclosing walls themselves of the building, as well as the space enclosed by them.

In setting forth the structural advantages derivable from the use of girders as the bases of floors, it may be necessary to insert a warning

against the use of girders of a material of uncertain strength, and of a treacherous character, unless means be adopted to prevent its strength from being tested within the possibility of danger, and to check its liability to snap across under any circumstances to which it may be exposed in use.

Cast-iron is of uncertain strength, because of the imperfections which the most careful and the most skilful founders, with the best materials and with every appliance at their command, cannot always wholly avoid, and which are most liable to occur in the production of complex forms in long lengths; whilst careless founding and rapid cooling are contingencies connected with the production of cast-iron girders,—which are necessarily long and complex castings,—and these contingencies add materially to the generally uncertain character which the substance possesses. Cast-iron is treacherous, inasmuch as it is brittle and liable to be startled into fracture by a force administered as a blow, or by impact trifling as compared with what it may have borne safely as a dead weight.

The writer of these pages witnessed in 1845 a series of experiments upon some cast-iron girders, which were calculated to break at 16 tons. Of five or six girders, of the same length and section, and presenting the same

appearance to the eye, some broke at 12 tons, whilst none bore 16 tons without breaking ; and one broke when under a pressure of about three tons, from a slight concussion. The man whose duty it was to read off the deflection as the pressure increased stepped quickly upon a girder which was used as a fulcrum in proving the girders upon which the experiments were tried, and consequently of much greater substance and strength than these. Perhaps the man may be said to have jumped upon the girder ; but the concussion occasioned thereby had to be communicated from it through the press to the girder under trial. With that slight shock, however, the girder under trial broke at less than one-fourth of the pressure it was calculated to bear. It showed imperfection in the fracture certainly ; but so did they all to the same extent at least ; and they all took a set at two tons of pressure, from which they did not recover upon the pressure being taken off.

Proving long metal castings by straining them upon their transverse section does but aggravate imperfections, and leaves the casting the weaker, therefore ; whilst no dead-weight proof is proof as against blows or other action inducing vibration. It is only under circumstances which do not admit of concussive action upon the beam, or which prevent it from vibrating under any shock that may reach it, that cast-iron can be

safely used in beams of long lengths to carry heavy weights without some appliance to mitigate the imperfections which this substance possesses. "Wood, however,"—to quote the words of Mr. Thomas Cubitt, the eminent builder, in the Supplementary Report which he made as one of the commissioners appointed to inquire into the causes of the fracture of the cast-iron girders which led to the fall of Messrs. Radcliffe's mill at Oldham in 1844—"Wood being much more "elastic, receives, without injury, shocks which "would be fatal to cast-iron; while its great "flexibility adapts it to give warning of its own "insufficiency, or of an undue pressure acting "upon it; whereas cast-iron, from its nature, "is incapable of affording the like demonstration of its weakness; and the fall of a building "so constructed, from the weight and solidity "of the material, is likely to be attended with "far more disastrous consequences."

The application of wrought-iron tension-bars as soles to beams and girders of cast-iron, would prevent the most serious consequences from attending the failure of the casting, if the girders were also prevented by binders or by other sufficient means from turning round when fracture of the casting occurs.

The foundation of a building of ordinary weight

is for the most part sufficiently provided for by applying what are technically termed footings to the walls. The reason for a footing is, that the wall obtains thereby a bearing upon a breadth of ground so much greater than its own width or thickness above the footing, as to compensate for the difference between the power of resisting pressure, of the wall and of the ground or ultimate foundation upon which the wall is to rest. It will be clear from this, that if a building is to be erected upon rock as hard as the main constituent of the walls, no expanded footings will be necessary ;—if upon chalk,—upon strong or upon weak gravel,—upon sand,—or upon clay,—the footing must be expanded with reference to the power of resistance of the stratum to be used as a foundation ; whilst in or upon made-ground, or other loose and badly combined or imperfectly resisting soil, a solid platform bearing evenly over the ground, and wide enough not to sink into it, becomes necessary under the constructed footing. For this purpose the easiest, the most familiar, and, for most purposes, the most effectual and durable is a layer of concrete ; concrete being in fact an artificial stone, which may be formed in blocks of any desired extent, and so as to cover a surface large enough to obtain from the most yielding soil the amount of resistance to pressure

required to support the weight of the intended building. It will be evident that upon a concrete foundation a footing or expanded base may or may not be required to a wall, according to the hardness of the concrete and the kind of wall to be built, but it is perhaps better to give the footing to the wall than to wait for the sufficient induration of the concrete to enable the wall to do without a footing.

Inasmuch, however, as some soils are liable to change in form, expanding and contracting under meteoric influences, as clays which swell when wetted and shrink when dried, concrete foundations are commonly interposed upon such soils to protect them from such influences, and so to protect the building from derangement therefrom ; or rather, to that effect walls are brought up from a level sufficiently below the ordinary surface of the ground of the cheaper material, concrete, instead of the more expensive brick or stone.

An error arising from the two distinct causes above indicated for the use of concrete for foundations may be pointed out here. It has been stated that when concrete is used to obviate the yieldingness of the soil to pressure, expanse or extent of base is required to answer the end, and to this effect the concrete being widely spread, should be thick or deep only with reference to its own

power of transmitting to the ground the weight of the wall to be built upon it, without breaking across or being crushed. But when concrete is used as a substitute for a wall in carrying a wall down to a low level, it is in fact a wall, wide only in proportion to its comparative weakness in the absence of manipulated bond in its construction, and encased by the strong soil within which it is placed. Hence the error referred to. Whether the proper object be the attainment of a sufficiently expanded base upon a weak soil, or of the sufficient depth below ground, in a strong soil it may be, to exclude meteoric influences, the erroneous notion is that a foundation is rendered strong in the use of concrete by depth rather than by extent of base, and in consequence of this notion heavy buildings are sometimes jeopardized by the friable concrete foundation being placed on its edge, instead of being laid flat to cover the breadth of soil necessary to withstand the weight of the superstructure.

Concrete, indeed, is at all times more safely to be regarded as a substance to be placed as a layer, than as a substance to be set up as a wall; for although with good materials, careful manipulation, and patience, excellent erections as walls may be made of concrete—as erections in the same form may be made of tempered clay—neither con-

crete nor tempered clay is to be regarded as a proper substance with which to form the lofty walls of buildings in towns.

The foregoing observations have reference almost wholly to vertical erections—of erections which bear directly upon horizontal foundations ; but it is to be borne in mind that although buildings in towns involve that kind of structure to a very large extent, they include also a great variety of structure which is not of that character, embracing the multiform arch as well as the simple pyramidically diminishing, but essentially vertical wall. An arch over an opening in a wall, or a common vault pressing against a wall, may tend to render insecure a structure in other respects fully adequate to its purposes of enclosing or of dividing buildings, and of bearing the greatest direct vertical pressure that can at any time be brought to bear upon it. The timbers of floors may be laid in, or be let into, walls so as to expose the walls to serious injury, and to lead to danger ; and roofs may be so composed and placed upon the walls of buildings as to thrust them out. Cantilevers acting as levers, and cornices only prevented from falling by otherwise superfluous parapets, and many other things, some of which pass under the name of architectural decorations, tend either to lessen the stability of walls, or to

impose the necessity of greater substance in their structure than would be necessary if such things, when applied, were applied with structural propriety.

Descending to subterranean and subway works, sewers under the carriage ways, and coal-vaults under the footways of towns, are but other forms of structure depending for their safety upon the same considerations as those which present themselves with regard to erected buildings, and involving also other considerations peculiar to themselves, and to each class of structure separately. Sewers are liable to blow up and to fall in ; to blow up from an overcharge of water, or either to blow up or to fall in from defect in structure, whether the defect be as it regards form proper to withstand pressure in any direction, defective materials, imperfect workmanship, or hurried execution ; and the result of an accident of any of the kinds indicated is the same—to let down the road under which the sewer had been made,—and in narrow streets, where the sewer had been laid in at a level lower than the foundations of the erected buildings on each side, to endanger, if not to let down, the buildings also. Vaults under the public ways connected with private buildings are peculiarly exposed to injuries which may lead to danger, even if they have been originally built

safely. They have, too, for the most part an important duty to perform as retaining constructions to the outer or carriage road. Liable as these constructions are to be undermined for house drains, and more frequently for cesspools, and liable, moreover, to be altered to fit them for other than the originally designed purposes, and, in London, certainly, built most commonly of the refuse of the brick-kiln, with the muck-like scrapings of the roads for mortar, it is a subject of constant wonder, with those who are informed upon the subject, and know how much of the safety of the ways above and of the houses about them depend upon these subway constructions, that accidents do not happen from this source of danger more frequently than they do occur.

In one of the narrow main thoroughfares of London some buildings fell down not long ago, and this circumstance brought suspicion upon other buildings in the same block, fronting to the same public road. One of these, a public-house, was found to have had its beer-way made through the crown of a vault which extended not only under the footway, but under the carriage-way also, and that a slight and half-rotten curb of timber held the vault up, with the scores of laden waggons, the hundreds of omnibuses, and the thousands of other vehicles which daily pass over it! The failure of the curb would most certainly have involved the

fall of the vault ; and as this would have fallen forward against a slight brick pier which was a main support of the front wall of the house above, whilst a heavy chimney in each of the two party-walls was without any other than the most frail support,—the original substructure having been either wholly or in great part removed for the sake of the space it occupied,—the inmates of the house, and the public in the street, were in constant and imminent danger of their lives.

It will hence appear that there are many contingencies connected with the structure of buildings, of whatever kind, that may affect their safety, and that many of the contingencies are of a nature to defy rules. General rules may certainly be made fairly applicable to the ordinary practice of building, but in the cases even to which such rules might be applicable, there will be some in which the rules will be found unnecessarily inconvenient to the builder on the one hand, or not effective as it regards the public on the other. In the cases which remain unprovided for by rule, discretion must be exercised, and if all works in and about buildings were in every case intrusted to the discretionary care of skilled and honest persons, discretion might safely be left there ; but inasmuch as this is very far from being the case in fact, and as prevention is better than cure, it

seems to be incumbent upon the State to make effectual provision to that effect for the protection of the public generally, and of human life under all circumstances, by preventing as far as possible the causes which tend to danger in the structure of buildings, as well as by arresting danger when it presents itself in a threatening attitude.

The fall of newly erected buildings in and in connexion with railway works has been a matter of such common occurrence of late years, and the destruction of human life thereby so frequent a result, that the fall of any ordinary structure might be allowed to pass unheeded, although life has been sacrificed by the fall. Railway works, however, are subjected to no supervision on the part of the public until they are completed, when supervision is a farce only equalled in absurdity by the watching of the flight of birds to ascertain coming events; and being subjected to no real supervision, the failure of railway works in progress, or barely finished, and the lamentable consequences which so frequently ensue therefrom, are taken as matters of course and not to be avoided. So it was in the recent case of the fall of part of the works in progress for widening the London and Greenwich Railway, whereby some unfortunate passers-by were killed; and when, moreover, the fall was attributed to every reason but the true one, which appeared to have been the premature striking of the centering; for although the centres

came down by the run through an accident, the accident happened in consequence of the preparations for striking them.

The fall of any building, however, which is supposed to be under the supervision of a District Surveyor, never fails to give rise to severe comments upon the conduct of the surveyor in the case, because he is supposed not only to have official cognizance of all buildings and of all building operations within his district, but to have power to deal with all such matters for the protection of human life. In the winter of 1845, a newly erected building, of which the walls had been undermined for some purpose the builder had in view, fell and killed the son of the unhappy builder, who was at work in it at the time of the fall; and the District Surveyor was immediately charged through the press, with gross neglect of duty in permitting a building to be built within his district so that it could fall down; but it appeared that in fact the District Surveyor had no information of the operation which had been attempted; and further, that he would have had no power to interfere to prevent, even if he had been informed of it.

At a somewhat earlier period a tavern-keeper at one of the places of public resort by the river side, in a district newly brought within the operation of a protective statute in relation to its buildings, and before it took effect, raised his house an additional story, and formed on the top of the new story a terrace-flat for the delectation of such of his summer customers as

might desire to drink their beer and smoke their pipes with a fine prospect before them. The story was formed by raising the slight walls of the house, already between 30 and 40 feet high, a further height of about 8 feet; the front and back walls, each about 16 feet in length, were raised of one brick in thickness, and the side walls, each about 30 feet in length, of half a brick in thickness, both materials and workmanship being moreover of the worst kind. A boarded and asphalted floor, placed upon these miserable walls, was surrounded by the brewer's sign and notice boards as a parapet, held upright by stay-rods, fastened to the floor in such a manner as to be liable to trip up sober as well as tipsy customers. With this erection, however, the Surveyor of the District found that, owing to the commencement of the works before the statute had come into operation, he was not authorized to deal, dangerous as he thought it to be, and dangerous as it certainly was, both as to structure and with reference to fire; and it was only by virtue of the provision of the Metropolitan Buildings Act, which makes it penal to use such a thing as the terrace-flat referred to for the purpose contemplated, unless it have been certified by the Official Referees to be safe in point of structure, that the use was prevented, and the danger removed. If the place had been used as it was when the District Surveyor took notice of it, and gave warning of the danger, it must almost certainly have fallen the first time that a boat-race or a

balloon had induced a moving crowd upon it, and in that event many lives would have been lost, and the District Surveyor would have been vituperated. Indeed the Legislature does not appear ever to have contemplated that buildings can be or become dangerous from any other causes than those which indicate ruinousness; whereas, in truth, by far the largest amount of danger exists where no indications to that effect present themselves—where, in fact, buildings are made dangerous by the act of the builder or other person having to do with them.

THE SECURITY OF BUILDINGS AGAINST FIRE.

THIS subject requires to be considered under two heads ;—

1st. The rendering buildings free from liability to take fire and to burn, and so to prevent fires.

2nd. The preventing the spread of fire from building to building, and so to insure against conflagrations.

And first as to the means of rendering buildings free from liability to take fire and to burn.

It is easy to understand that this object may be fully effected in particular cases ; but as it cannot be effected without much greater expense than can be reasonably incurred, having reference to the risk, under ordinary circumstances, it is proposed to limit the inquiry in this place to the means of rendering buildings of ordinary construction, and particularly dwelling-houses, so far free from the liability in question, that they may

be inhabited, or otherwise occupied, with the smallest amount of danger to human life.

It is seldom that dwelling-houses and such like buildings take fire and are burnt from the common accidents against which it is practically impossible wholly to guard, such as those which occur to the lighter movable furniture, and to the drapery used in them ; but, for the most part, the danger arises from the exposure of timber in some form or other in or about the structure, to the continued action of fire, or of heat capable sooner or later of inducing the combustion of timber ; and as the source is most commonly in some stove, furnace, flue, pipe, or other tube for generating or for conveying heat, or for removing the products of combustion, much of the real danger to buildings from fire would be prevented by preventing that degree of proximity between timber and all such things as can lead to the combustion of the timber. That buildings do not take fire and burn more frequently than they do so, proves that to a great extent precautions are taken, and that dangerous proximity between the conduits of fire or of heat in a condition to induce combustion, and the combustible materials in the composition of buildings, is prevented. But those persons only whose business it is to know of, and whose duty it is to inquire

into such matters, can conceive the extent to which buildings are exposed to latent danger in that respect, and none, perhaps, but such persons can fully estimate the importance of enforcing precautions to the effect indicated.

The total number of fires in the Metropolitan district in the 12 years from 1833 to 1845 inclusive, was 7285, of which the causes of 5515 only were known, and of these 1165 were found to have arisen from flues and fire-places improperly constructed,—from furnaces,—heating and cooking apparatus,—pipe stoves,—drying stoves,—bakers' ovens,—and kilns.

Mr. Braidwood, the able and intelligent superintendent of the London Fire-Engine Establishment, from whom the information contained in the last preceding paragraph was obtained, stated in evidence before a Committee of the House of Lords last session, his belief, from observation of many instances, that by long exposure to heat not much exceeding that of boiling water, timber is brought into such a condition that something like spontaneous combustion takes place; that the time might be eight or ten years; that is to say, it may have taken so long for the heat from pipes charged with or used to convey steam, hot water, or heated air, laid among the joists of a floor, or in the heart of a partition, or elsewhere in a building, encased in timber, to induce the condition necessary to the actual ignition of the timber.

Day and Martin's well-known blacking manufactory in London is, or was, heated by means of hot water passing through iron tubes into the various parts of the building. In December, 1844, the wooden casing and other woodwork about the upright main pipes were found to be on fire, and from no other cause that could be discovered than the constant exposure for a long time of the wood to heat from the pipes. In this case the pipes were not in contact with the wooden casing, but they were stayed and kept upright by cross fillets of wood which touched them, and these it was which appeared to have taken fire. The small circulating pipes which conveyed the hot water throughout the several chambers, were raised from the floor to about the extent of their own diameter, and the floors showed no signs of fire where the pipes were so removed; but in every case where the prop or saddle which held the pipe up from the floor had been displaced, and the pipe had been allowed to sag and touch the floor, the boards were charred. It was understood that the temperature of the water in the pipes never much exceeded 300 degrees.

In most existing buildings, indeed, such precautions are the only means of preventing the danger: but, in building anew, the danger which fire in a building brings with it may be allayed by disposing and arranging the requisite timber with matters of an incombustible nature, in such manner as to check its liability to inflame, and so

to extend the fire, if ignition of the timber in any part should take place.

With a view to lessen the danger to which buildings with timber in their structure are exposed from fire, it will be well to consider, in connection with the disposition and arrangement of timber in the various forms in which it is usually employed in buildings, how far the timber, and wooden fittings commonly used, may be necessary to either the stability of the buildings, or the comfort, or even the convenience, of the future occupiers.

So long as danger of fire is brought to buildings through pipes and tubes, the necessity must be admitted of guarding the combustible materials used in buildings from any chance of becoming ignited. When heat is produced and passed through pipes in any manufactory, whether it be to act as power, or for drying or for warming, the fires used may be guarded, and the machinery which regulates the intensity of the heat to be transmitted may be under constant care; but even in such cases there can be no certain assurance that the heat shall not at some time arrive at the point of danger as it regards the ignition of combustible substances. But when heat is diffused throughout dwelling-houses by means of apparatus the safety of which is committed to persons un-

skilled in its use, and unconscious or careless of the danger which may arise alike from hardihood and from neglect, it seems impossible to lay down inflexible rules for distances from timber which shall render hot air, hot water, and steam pipes safe. Twelve or fifteen inches may not be a greater distance than safety requires under some circumstances, whilst there are many cases in which actual contact of such pipes with timber is not inconsistent with safety. When the air about the heated bodies is not confined, as it is between the joists and the floor and ceilings of an ordinary floor, a distance between timber and the heated surface equal to the longest diameter of any tube or pipe, will be found a safe distance when the temperature does not greatly exceed that of boiling water.

Under ordinary circumstances the half-brick thickness of brickwork which separates the inside of a common chimney-flue from the inside of a building does not become heated to such a degree as to justify the slightest alarm for the safety of timber in contact with the outside of the brickwork, but it is so difficult in practice to secure the complete filling in with mortar of the various parts of brickwork,* that prudence dictates the

* The complete filling in of the heading joints of brickwork is not very important as it regards the structure, in

propriety of requiring the surfaces of the work, both inside and outside any chimney-flue within a building, to be plastered over to stop imperfect joints, and so to prevent the lodgment of soot, which a spark passing up the flue will enkindle, and which, being enkindled, will endanger the safety of the building through a joist, a flooring-board, or a wooden skirting which may abut upon or lie against the unstopped joint towards the inside of the building. Not only indeed are the joints of the brickwork often left unstopped with mortar, but wooden plugs are driven into them, and often quite through into the chimney-flues, to afford the means of fixing the wooden skirtings; and these are perhaps the most frequent means of communicating fire from the flue to the skirtings, and so to the inside of the building.

“On Saturday the 9th October, 1847,”—the newspapers relate—“Broughton Old Hall, near Manchester, was partly destroyed by fire, and damage was done to the extent of nearly 1000*l*.
“The fire was entirely subdued in less than two

buildings of ordinary character, and bricklayers, from the habit of neglecting those joints, can hardly be induced to take the additional care necessary to fill them perfectly with mortar in the formation of flues, even if their employers would consent to the slight addition to the cost of their labour which any additional care occasions.

“ hours, after destroying a large portion of the
“ roof and of the cupola over the south front,
“ besides the upper part of the grand staircase.
“ As the walls and ceilings were in course of
“ receiving embellishments, they also suffered
“ much injury both from fire and water. The
“ disaster is attributed to the joiners on the
“ previous night having left a very hot fire in
“ one of the rooms, which had ignited some
“ plugs, the ends of which in one direction com-
“ municated with the flues, and in the other
“ with the skirting-boards of the room.”

But even common chimney-flues are liable to be so used, or so abused, as to endanger the building in the walls of which they occur, by the overheating of the brickwork by which they are formed. The flues of ovens and other furnaces, and of stoves used to engender heat of great intensity, are unhesitatingly let into common flues, even in party-walls, with only a half-brick between the fire and the timbers of the adjoining building; and another very common source of danger from chimney-flues arises from the habit before referred to, of obliterating some of the chimneys in the lower stories of dwelling-houses upon adapting them as shops, when the remaining upper portions of the flues of such chimneys are said to be dead. Dead as they are, however, they are frequently taken into use at a higher level to serve a stove,

or for a new chimney ; and the inlet to the dead flue being generally at a higher level than that at which it has been shut off, soot falls down, and in time fills the sack or pocket ; and the mass of soot so accumulated casually taking fire, and smouldering unconsumed, heat enough is generated to ignite any combustible substance in contact with the brickwork which encloses the smouldering mass.

The daily returns made by the London Fire-Engine Establishment to the Insurance-offices, state the supposed causes of the fires which occur, and from these it appears that more than one-half of the fires *which have reached the structure of buildings*, are considered to have originated in defective or overheated chimney-flues, in dead flues, or in some of the many varieties now in use of stoves and furnaces, and their metal tubes or other adjuncts and accessories for the purpose of distributing heat, and in some cases for removing heated air, as in removing the products of the combustion of gas. Further investigation generally justifies the supposition of the officers of that establishment as to the cause of the fire in any case, and for the most part proves that the danger had arisen, not from accident properly so called, but from arrangements which admit of casualty, and, generally, arrange-

ments made contrary to existing legislative provisions for preventing such casualties.

A valuable building, used as a club-house, in Gresham-street in the city of London, was seriously damaged by fire in the [present] month of October, from the placing of a series of small furnace-fires, to form what is termed a hot-plate, upon the wooden and timber-formed floor of the kitchen of the club-house, the thin brick hearths of the furnaces being literally bedded upon the flooring-boards. The Metropolitan Buildings Act provides, "as to every furnace
"used for the purpose of trade or manufacture,
"that it must not be placed upon nor within a
"distance of 18 inches of any timber or wood-work." But the cooking for a club is not a purpose of trade or manufacture !

It is not certainly by neglecting all reasonable precautions with regard to chimney-flues, stoves, furnaces, and such matters, that security from fire is to be attained, but inasmuch as the removal of all such things as pipes for conveying heat in any form to a certainly safe distance from timber and all other combustible matters, would be, in effect, to prohibit their use in all ordinary buildings ; and inasmuch as the removal of timber from the vicinity of chimney-flues, and of stoves and furnaces from timber, so as to prevent the possibility of accident by fire arising therefrom, cannot be enforced with that amount of certainty necessary

to absolute security in that respect, it will be far better to conjoin with reasonable rules to prevent accident by fire in a building, provision for rendering the building less susceptible of fire if by accident any of its parts become ignited. To this effect the following observations will apply:—

Desiring to avoid interference with the internal composition of buildings, the legislature in this country has generally confined itself, when it has legislated upon such matters, to making provision that the outer or enclosing walls—the front, back, and side walls—of buildings, should be built of certain incombustible building materials. In providing to this effect it has been thought necessary to provide of what least thicknesses such walls might be built, and generally these were determined with reference to the height of the building, and to the area to be enclosed in every case, as an indication of the probable lengths of the walls; and both for the purpose of promoting safety of structure, and of checking the spread of fire from building to building. Inasmuch, however, as in most cases greater thickness is required in a wall of ordinary construction, taken as one of the side walls of an ordinary dwelling-house in a town, to render its structure secure, than is necessary to enable it to prevent a fire in the building on one side, from passing into that

on the other side of it, some of such walls have been directed to be of greater thickness than would be necessary to fulfil the objects which the legislature has had in view, if the walls were not supposed to extend the whole length of the two longer sides of a parallelogram without intermediate cross or return walls. A solid brick wall—that is to say, a wall of which the joints as well as the beds are perfectly filled with mortar—one brick or nine inches thick, between any two ordinary dwelling-houses of five or six squares in area each, will prevent fire occurring in one of such houses from being communicated through it to the other of them.

It may be sufficient proof of this assertion to state, that although chimney-flues which have become foul frequently take fire, such flues being enclosed by half-brick, or four-inch, brickwork only, if the brickwork be without timber in it, and be solid, or be only well plastered over, fire is not communicated to the building adjoining the wall in which the fire may be, except in the cases of dead flues before referred to, and of oven and other furnace flues being let into a common flue, when the mischief is brought about by the long continuance of intense heat.

But, in towns, ordinary dwelling-houses which occupy each an area of five or six squares, are generally disposed in plan as parallelograms,

having their opposite sides 18 or 20 feet, and 28 or 30 feet respectively in length, and are seldom carried up to less heights than 35 or 40 feet; and walls of such lengths and heights could hardly be deemed safe, if not more than one brick thick. Consequently, a greater thickness has been prescribed, as the least thickness of the walls of buildings of the sizes indicated. In the older Metropolitan Building Acts much greater thicknesses were prescribed for the walls likely to be the longer walls; whilst the only necessity for more than one brick arises from structural requisites, and not from any insufficiency of a wall of solid brickwork, one brick thick, as a means of preventing the spread of fire. But the requisites of the structure would be as well fulfilled by one-brick walls upon the long sides as by $1\frac{1}{2}$ -brick walls, if the ordinary internal cross partition for dividing a house into front and back rooms, were built of brickwork abutting upon, and at right angles to, the longer walls, and carried up coursed and bonded with them:—that is to say, party-walls of one brick or nine inches in thickness, connected at their ends by $1\frac{1}{2}$ -brick or 13-inch front and back walls, and at or about the middle of their length by other 9-inch cross walls, would be as strong as, if not stronger than $1\frac{1}{2}$ -brick party-walls, though connected in the same

manner at the two ends, but without the abutting and connecting cross-wall of brickwork. Instead, however, of such internal cross walls, hollow partitions of timber are commonly used in all stories above the basement story ; and it is by these partitions, and by the light and highly inflammable wooden stairs, that fire extends itself so rapidly throughout ordinary dwelling-houses, whilst the substitution of a brick wall for the cross timber partition, would, in most cases, at the same time justify the abatement of a half-brick of the thickness otherwise necessary to party-walls, and give an indestructible internal support to the floors, whereby also one of the means by which fire travels with such fearful rapidity through a house would be removed. It is true that there must be openings as doorways, and fittings in them for doors, in such internal partition wall ; but the wall could not carry fire up from floor to floor through its own heart, as the hollow wood-lathed quartering partition carries it. Doors and shutters, and door and window linings, in and against brick or stone walls, may take fire and burn in any story of an ordinarily built dwelling-house, without carrying it beyond the story in which the fire occurs ; for a plastered ceiling, of the most common description, will resist the action of flame upon its surface for

a long time, and plastering of really good quality, though upon wood laths, will keep fire off from the joists by which it is held up, almost without danger, so long as the fire acts upon the face only of the plastering. If, however, fire reach the joists through the agency of hollow quartering partitions, the enemy has turned the flank of the plastering, and the floors and skirtings above and behind it taking fire, the building almost inevitably falls a prey to the flames, and too often with loss of life to some of its inmates. Any step, indeed, from the hollow quartering partition towards a solid wall, is a step towards security. A brick wall is, perhaps, the best internal partition for all the purposes of strength and safety from fire; and in small houses, which will not afford the expense of 9-inch walls, half-brick walls with 9-inch jambs at the doors, and short 9-inch piers on alternate sides of the partition, at intervals of three or four feet in length, will give sufficient strength, but even quartering partitions, if based upon brick walls, may be rendered nearly proof against fire by brick-nogging them, especially if care be taken to fill in with brickwork between the joists over the head of one partition and under the sill of another, as well as between the timbers of the partitions. Filling in between the joists, and up as high as the skirtings go, will

do something, indeed, towards diminishing the dangerous tendency of even lathed and plastered timber partitions; whilst the adoption of the plan now commonly practised in Paris, in forming not only internal partitions, but the rearward external enclosures of buildings, would secure to the structure the structural efficiency of timber in carrying weight, and give the solid and incombustible character of a brick or stone wall to a partition or enclosure which is structurally of timber.

The plan referred to is, to frame and brace with timber quarterings much in the manner practised in England, except that the timber used in Paris is commonly oak, and is very generally seasoned before it is applied in building in the manner referred to; and that, as before remarked, the carpenter's work, or *carpentering*, of the French is not so good as that of the English. The framed structure being complete, strong oak batten-laths, from two to three inches wide, are nailed up to the quarterings horizontally, at four, six, or even eight inches apart, according to the character of the work, throughout the whole height of the enclosure or partition; and the spaces between the quarterings, and behind the laths, are loosely built up with rough stone rubble, which the laths, recurring often

enough for that purpose, hold up, or prevent from falling out until the next process has been effected. This is, to apply a strong mortar, which in Paris is mainly composed of what we know under the name of Plaster of Paris, but of excellent quality, laid on from or upon both sides at the same time, and pressed through from the opposite sides so that the mortar meets and incorporates, imbedding the stone rubble by filling up every interstice, and with so much body on the surfaces as to cover up and embed also the timber and the laths;—in such manner, indeed, as to render the concretion of stone and plaster, when thoroughly set, an independent body, and giving strength to, rather than receiving support from, the timber.*

Our brick-nogged partition is, in point of structure, nothing, but through the aid of the timber; the plastering is merely spread out upon the surfaces of brick and wood, and is fragile in the extreme, and always liable to crack and drop off; whilst, on the other hand, according to the French practice, the mortar, meeting through the interstices of the

* The author is not aware whether this plan is peculiar to Paris or not, nor even whether it originated in that city. Lath-and-plaster was formerly used in Paris as in London, but the practice referred to now prevails in buildings of all kinds, and in all parts of Paris and its suburbs.

rubble, becomes one consistent mass throughout the whole thickness of the partition, and keying over the horizontal batten-laths, it requires only thickness enough,—which in practice is freely given,—to bear over the width of the lath. Our lathed and plastered partition is composed of the hollow framework of the timber quarters, with two slight thicknesses of mortar, as plastering, hung upon slighter laths, over and between which the flaccid mortar forms a key for itself; but all necessarily depends upon the timber, and fails with it wherever decay or fire may destroy it.

Only second in importance to the internal partition as a source of danger or as a means of safety, are the stairs; and the stairs are second in importance only when the partitions are made to carry the floors of the several stories. When the staircases are of wood, and are connected with the entrance door and at the several landings, by wooden floors, the stairs, which ought to afford safe means of escape from the upper stories in the event of accident, become the most dangerous compartment of a building if the staircases are made and finished according to the English practice. In England, and in London particularly, even when the steps and intermediate landings are of stone, it is but too common to find the passage from the street door to the foot

of the stairs, and the floors which connect flight with flight at the several landings, either wholly of wood or of slight stone paving laid upon wooden joists or bearers. Any stone paving upon wooden joists will certainly retard the action of fire upon the joists, especially if assisted by a well-plastered ceiling; but in this, again, if the floors be not formed of wholly incombustible materials, the French practice as to floors would be better than ours. But, first, as to the stairs.

In Paris stone stairs are far less common in modern houses, than they are in London in houses of corresponding character and date; but wooden staircases in Paris are rendered almost, if not altogether, as safe, at least, as common stone staircases are made with us, by a process similar in character to that applied to partitions and enclosures. The same strong batten-laths are applied to the soffits, or under surfaces of stairs, and the spandrels, or irregular triangular voids, formed under the steps and risers, are filled in over the laths with stone rubble, packed up so as to rest upon and be supported by the laths. Mortar is then forced up from below into the rubble, and made to pass through and incorporate the rubble into a concrete mass, and so as to extend over the laths which carry it, and produce as neat a surface as if the plaster were merely held up by keys

through slight laths as with us ; whilst the result in the one case is an almost incombustible structure, and in the other an easily inflamed and rapidly inflammable piece of hollow woodwork. Wooden staircases formed between brick or stone walls, or between partitions of the kind above described, as commonly made in modern buildings in Paris, filled with a solid mass of concreted rubble, may perhaps be set on fire, but they can hardly burn.

It has been remarked that a mere plastered ceiling will resist the action of fire for a long time, though the plastering be upon wooden laths, and the laths nailed to joists of timber ; and as fire does not readily act downwards, flooring boards may take fire from above without any immediately serious consequence to the joists under them, so long as there is no access of air from below. But our in-door plastering upon laths is, for the most part, of the most fragile kind, and the slightest weight falling upon the back of a ceiling, will too often make a breach through it, whilst our floors are commonly of deal laid upon fir joists, and are exposed to the action of fire from below directly the lathed and plastered ceiling has failed ; if, indeed, the enemy be not led up, and introduced to, the joists under the flooring boards by the hollow lathed and plastered

quartering partitions. In the timber enclosures and partitions, which economy induces the Paris builder to introduce as substitutes for walls, the timber is so embedded in and made part of a solid concrete, as to be protected from almost every casualty of which it is susceptible, and the building is insured against almost every possible chance of danger from its failure.

But the French render their floors also so nearly fire-proof as to leave but little to desire in that respect, and in a manner attainable with single joists, as well, at the least, as with joists framed into girders. According to their practice, the ceiling *must* be formed before the upper surface or floor is laid, inasmuch as the ceiling is formed from above, instead of from below.—The carpenters' work being complete, strong batten-laths are nailed up to the under sides of the joists, as laths are with us ; but they are much thicker and wider than our laths, and are placed so far apart, that not more, perhaps, than one-half of the space is occupied by the laths. The laths being affixed—and they must be soundly nailed, as they have a heavy weight to carry—a platform, made of rough boards, is strutted up from below parallel to the plane formed by the laths, and at about an inch below them. Mortar is then laid in from above over the platform, and between

and over the laths, to a thickness of from two inches and a half to three inches, and is forced in under the laths, and under the joists and girders. The mortar being gauged, as our plasterers term it, or rather, in great part composed of plaster of Paris, it soon sets sufficiently to allow the platform—which, it will be readily understood, has performed the same office to the mortar which centering performs to the parts of an arch or vault—to be removed onwards to another compartment, until the whole ceiling of any room or story of a building is formed. The plaster ceiling thus formed, is, in fact, a strong slab or table, in the body of which the batten-laths which hold it up safely in the air are incorporated, and in the back of which the joists, from which the mass is suspended, are embedded. By the process, the under surface of the plaster table has taken from the rough boards of the platform the roughness requisite to facilitate the adhesion of the finishing coat of plastering, which is, of course, laid on from below.

Such a ceiling as that described, produced in the manner referred to, will resist any fire that can act upon it from below, under the ordinary circumstances of an incendial fire; and it would be difficult for fire to take such a hold from above as rapidly to destroy the joists to which a ceiling so

composed and applied is attached, the laths and the under side of the joists being alike out of its reach; and consequently such a ceiling alone would diminish the danger to buildings from fire, although the floor above the joists were formed with deal boards. But a boarded floor is a luxury in Paris, and is not to be found in the dwellings of the labouring classes, nor, indeed, are boarded floors to be found in any dwelling-houses but those of the more costly description. Whether the eventual surface is to be a boarded floor or not, however, the flooring joists are covered by a table of plaster above, as completely as they are covered by a plaster ceiling below. —Rough battens, generally split and in short lengths, looking like ends of oak pales, stout enough to bear, when laid from joist to joist, the weight of a man without bending, are laid with ends abutting upon every joist, and as close together as they will lie without having been shot or planed on their edges, so as to joint them. Upon a rough loose floor thus formed, mortar of nearly similar consistence to that used for ceilings, but not necessarily of the same good quality, is spread to a thickness of about three inches; and as it is made to fill in the voids at the ends and sides of the floor-laths upon the joists, the laths become bedded

upon the joists, whilst they are to some extent also incorporated with the plaster, and the result is a firm floor, upon which, in ordinary buildings, and in the public and commoner apartments of almost all buildings, paving-tiles are laid, bedded and jointed in a tenacious cement to form the working floor.

It must be clear that the timbers of a floor so encased could hardly be made to burn even if fire were let in between the floor and ceiling, as by a London lathed and plastered quartering partition. But it has been already stated that the practice of making these almost fire-proof floors is connected with the use of walls which have no timber laid in them bedwise, and that the timber enclosures employed instead of walls, and the internal partitions, are rendered practically fire-proof, whilst the wooden staircase which economy dictates to the Parisian builders,—the freestone which is used in building walls being altogether too soft for the purpose,—is also rendered, in the manner already shown, almost unassailable by fire.

Floors formed in the manner above described are not peculiar to Paris, nor is the practice new; but the author has never witnessed the process of forming them anywhere but in Paris. Probably such floors are to be found wherever

gypsum offers itself freely, as it does at Paris; and we have, indeed, instances of a similar practice in England under such circumstances. At Nottingham, in the neighbourhood of Charnwood Forest, where gypsum abounds, the floors of all houses were, till of late years, universally formed by an almost exactly similar process to that employed at Paris—stout reeds, however, being strewed over the joists as a basis instead of split battens. The practice at Nottingham adds small coal and cinders to the plaster of Paris (gypsum) in making the mortar, and the surface is at once trowelled over to finish. In this manner is produced an almost indestructible floor, capable of any service, and so secure a protection against fire, through its imperviousness to air, that, notwithstanding the unceiled and exposed joists below, houses in Nottingham are said never to be burnt, whilst the floors are said to be free alike from damp and from vermin.

It may be worth remark here, having reference to the employment of any substance such as cinder, being of the nature of pozzolano, or volcanic scoria, in mortar, to form a floor in the manner and of the substance above described [about three inches thick], that as all such mortars expand in setting, the walls of buildings may be forced out, and even thrown down, by the expansion of the plaster floors, if the whole surface of the floor in any story be at once covered with the mortar. A margin on every side of four or five inches, according to the size of the floor, should be left void

until the expansion of the body has taken place, when the floor may be completed with an assurance of close joints, and without injury to reasonably stable walls.

It may be added in explanation of the statement, that in Paris the practice of forming a table of plaster over the joists when tiles are to be used as the flooring surface, is employed also when a boarded floor is to supervene,—that as the surfaces of the true joists lie under the mortar or plaster table, a base is formed for the boards of what English carpenters would call stout fillets of wood, about $2\frac{1}{2}$ inches square, ranged as joists, and strutted apart to keep them in their places, over the mortar table, to which they are sometimes scribed down, and that to these fillets, or false joists, the flooring boards are secured by nails; so that in truth the boarded floor is not at all connected with the structure of the floor, but is formed upon its upper coat of plaster. The wooden floor thus becomes a mere fitting in an apartment, and not extending beyond the room nor over the passages and landings to the stairs, the floor in any room might burn without communicating fire to the stairs, which, in their turn, if they could burn, could hardly endanger the immediate safety of any inmate of the building, because of the complete separation

which the tiled and plastered floor of the landings effects between the wooden stairs and the several apartments.

The French practice above described renders the occupiers of one story of a building free from liability to be annoyed by noise in the story above; and there can be no doubt, indeed, that the custom of several families occupying the same house by stories, so that each family in Paris may be said to have its story rather than its house, led to the practice as an essential convenience; whilst with us each family more commonly occupies its house, and walls, instead of floors, separate the several occupancies, and the limitation of noise to the story in which it may be occasioned is a less essential object. But the object being a desirable one nevertheless, it is sought to be attained in England by what is termed pugging, a process in every respect inferior to that employed by our neighbours. It may be further remarked, as incidental to the subject, though not necessarily connected with it, that although the French do not employ joiners' work in the fittings and finishings of their buildings to the same extent that we do, and they are not such good joiners as we are, their boarded floors are always tongued in the joints, and almost always parquettèd, and so resolved into compartments of various figures; and being tongued and edgenailed, no nail or brad heads appear upon the surface to dot over and disfigure the floors,

which, being for the most part of wainscot, are thus made far more sightly than the best executed deal-battened floor with us.

In applying the foregoing observations to the practice of building in England with a view to show that our ordinary buildings may be rendered generally less inflammable, and altogether less susceptible of fire, without increasing the cost of building, it is necessary to suppose that the requisite skill and tact necessary to any peculiar process that may be involved has been acquired. Either the rubble-wall builder, be he bricklayer or mason, must acquire much of the skill of the plasterer, or the plasterer must learn to pack up brick or stone rubble into the form of a wall, and to give more effect to the mortar with which he plasters, than when he pricks up against a lathed partition or ceiling, or renders the face of a brick wall; and he must learn to nail up laths as firmly, at least, as a fencer nails split pales; the plasterer must, indeed, cease to be a mere coverer of surfaces, or a new trade must be formed of men who shall combine the rough carpenter and the building mason with the plasterer, before enclosures and partitions can be made to stand up with rubble and mortar, holding incorporate the framework from which it

derives strength, and to which it may nevertheless lend both firmness and consistence.*

The necessity which arises with us of dividing the upper stories of houses into more rooms, as bed-rooms, than are commonly required in the lower stories, will be made an objection to any process that would have the effect of rendering the partitions heavier; but it is not in the upper or bed-room stories that the lathed and plastered partition is most dangerous in respect of fire. Generally the stairs of a house may be enclosed by solid partitions throughout almost the whole height of ordinary dwelling-houses without occasioning any inconvenience as it regards the greater weight of such a partition; and generally, too, the partition which divides the front from the back rooms of such houses may be carried up throughout the whole height of a house without removing the bearing, if the house be judiciously disposed to that effect. But even if a partition rest upon a beam or girder, a very slight addition to the scantling of the timber will make up for the additional weight which the filling in of the partition would bring with it, if the materials of the core be well chosen; and it is well known that a

* See also suggestions for the composition and arrangement, as to structure, of floors required to be wholly fire-proof, as a means of preventing the spread of fire, p. 173, *et seqq.*

piece of timber placed over a void and carrying a wall resists the action of fire for a long time, and the longer if it be of oak or other hard wood, which under any circumstances does not ignite so readily as fir timber. It is not necessary, however, that the timber employed in partitions and enclosures should be of oak, because oak is the kind of timber most in use for such purposes in Paris, though it is certainly highly desirable, nevertheless, that main bearing timbers in situations which render them most liable to be exposed to the action of fire, in the event of casualty, should be of such-like timber rather than of the more easily ignitable fir; but the quarterings, or partition timbers, which the plaster concrete wholly encases, may be of fir, as safely almost as of oak.

The core used in Paris is, as already stated, rough stone rubble; and it is for the most part chips and spalls arising in the process of dressing the soft freestone which is the main constituent of the walls of most buildings in that city. Almost any hard material, however, will furnish a kind of rubble fit for the purpose, the only essential conditions being that the material be as hard at the least as mortar of ordinarily good quality when set, and that the rubble be so angular and irregular in form, as to be capable of

being so packed up between the quarterings and inside the laths, as to allow the mortar to pass freely through, and embed it all, whilst it meets and incorporates from the two sides. Rubble of brick material, as broken burrs, or even of old bricks freshly broken, will answer very well ; but if brickbats or even shreds of plain tiles be used, care must be taken in packing not to bring flat beds together, or the mortar will not pass through and make a perfect concrete. Rubble of almost any kind of stone may be used, but it will be evident that the kinds of stone which are themselves concretions and present rough surfaces upon the fracture, yield the best rubble ; and schistose, or scaling slaty stones, the worst for the purpose. But there is no better substance for coring partitions upon the plan described than clay burnt into a kind of brick rubble,—an excellent ingredient indeed in concrete for any purpose.

As a further means of economising in materials, old timber that is sound may be freely used in new buildings for the quarterings of partitions to be enveloped in the manner described, as old nails will not interfere with the irregular lathing which the process admits of. The eggs and germs of insects which the timber may carry will be rendered as harmless as flies in amber, and as quiescent as a toad in a rock, whilst the continued

soundness of the timber will be insured by its incorporation in the plaster concrete.

The same process applied to external enclosures will justify the use of timber in their structure in situations and under circumstances in which it may be properly prohibited when the timber is merely lathed and plastered or even bricknogged, for bricknogging adds nothing, as already remarked, to the strength of a partition or an enclosure, but rather takes from it, being itself a source of infirmity. But chimneys and their flues ought not under any circumstances to be made or formed in an enclosure in which timber is employed as a part of the structure. Chimneys, with their congeners, stoves and furnaces, should be confined to walls of brick or stone; and as these almost always occur most conveniently in party-walls when buildings stand together, or in walls which, though not technically party-walls, are so near to other buildings, or buildings in other occupation, as to require to be similarly dealt with, enclosures of the kind indicated need not be desired, because it would not be prudent to form flues in them.

Under some circumstances again,—that is to say, when any street of a town is so wide and the buildings to be built fronting to it are to be so low in height as to make the communication

of fire from buildings on one side to buildings on the opposite side so nearly impossible as, for all the purposes of regulation, to be so, if the buildings adjoining laterally are effectually separated from one another by sufficient walls, party or otherwise, and these project before the outside faces of the front and back enclosures so as effectually also to prevent fire from passing round them,—the temperature of dwelling-houses may be much more easily maintained and regulated if the outside surface be boarded. What is known as weather-boarding is, as it regards the weather-boarded building itself, a safe and economical, as well as a neat, wholesome, and equable outside casing for the fronts of a dwelling-house, if it be backed up solidly, and the timber quarterings necessary to secure it be properly filled in between and behind with brick or stone work, or with rubble and concrete in the manner hereinbefore described. Brickwork builds up badly with the raking braces of timber-framed enclosures, and the concrete described would not be so perfect with weather-boarding on one side as if the mortar were thrown in from both sides; but raking braces are less essential to enclosures which are filled in and backed with a heavy body of brickwork or concrete, than when mere lathing or even bricknogging is to be employed on the

inside. A 9-inch brick wall may, indeed, be very well built up with framed quarterings without raking braces, if the work be built between and around the quarterings, that is to say, carrying the inner half-brick before the inside faces of the quartering, and so as to show on the inside a plain brick wall.

In places where stone is easily obtainable, but of a kind, it may be, so susceptible of moisture as to be unfit for the outside walls of buildings if exposed to wind and weather, comfort may be obtained and economy secured in most cases by the use of weather-boarding externally and a plaster and rubble concrete backing and coring, which will give also the requisite protection to the timber against fire; but without such precautions fully carried out, outside boarding of any kind is not to be considered safe; whilst any such covering may be rendered absolutely dangerous under any circumstances by the very foolish custom which prevails in some places, of paying it with pitch.

The very destructive fire which took place at Gravesend in July of this year (1847) was attributed to lightning. The weather-boarded coverings of some of the houses or other buildings which were destroyed, had been newly payed with pitch in the course of the evening the storm, out of which the accident arose,

came on, and this probably admitted of readier ignition than cold and hardened pitch ; whilst the circumstance that almost all the buildings of the locality affected, were of timber, weather-boarded, and that the weather-boarding was to a great extent payed with pitch or with tar, fully accounts for the little effect produced upon the fire by all the usual means for subduing fires that could be brought to bear upon it. But it is to be observed that this was not weather-boarding backed up, and timber framing imbedded, as supposed in the text.

The wooden stairs of buildings would be much less exposed to fire than they are under ordinary circumstances if they were enclosed by walls or by solid incombustible partitions, and were connected at the several stories by floors, or rather by landings, which have been made or rendered fire-proof ; but as the stairs compartment of a house is the most important as it regards the safety of the inmates in the event of fire, there can be no excuse for making wooden staircases so exceedingly inflammable as they are continually made in England, when such an easy means as that herein described presents itself, of diminishing the liability of such staircases to take fire and to burn.

Additions made to houses, or attached buildings

carried up before or behind them to the height of the story next above the street or other ground level, as projections are made before and behind houses in our towns to enlarge the ground-floor stories, have the effect of cutting off all means of escape, in the event of fire, by the windows of the upper stories, to the extent to which such projected parts lie under the windows; unless the roofs or flats be so formed as to resist the action of fire, and admit of a passage over them though a fire be raging below. The roof coverings of all such additions to a building as lie before and under the windows of the upper stories, for whatever purpose made, and whether they be for shops, or as porches or porticoes, or as enlargements rearwards, ought, for the safety of the inmates, to be so constructed and supported as to resist the action of fire, and to permit a passage over them in the event of fire in the building.

One prolific source of dirt, discomfort, and danger in and to our houses is the wooden skirting so commonly used in England to form the bases of rooms, and as a means of preventing chairs and other articles of furniture from touching the papered or painted surfaces of the walls and partitions. If the plastering be carried through the thicknesses of the

floors, and whatever plinth may be thought desirable as a base to any room be formed in plastering, the flooring-boards or other flooring surface being stopped against the surface of the plastering,—a shallow fillet of wood, moulded or plain as the case may require, and bradded or screwed to the floor, will give all the useful, and, with the plaster plinth, all the decorative effect of a wooden skirting, and there will be no longer a hollow box for the reception of flue and dirt, and as a nidus for vermin, nor a way for cold draughts, nor will there be a highly inflammable substance placed in dangerous proximity to any chimney-flues in the walls, and in a position to receive, to communicate, or to extend fire from whatever source it may be derived.

The insides of our houses, and other buildings partaking of the same character, are often further made most gratuitously inflammable by battening out upon the faces of the walls to accommodate the deep boxings thought necessary for window-shutters. Walls are thus made to look half as thick again as they really are, whilst the cost and the space, which the greater thickness of wall would have incurred and absorbed, are applied to make the building more susceptible of fire. But, in truth, in most cases neither the cost nor the space need be given, inasmuch as the inside

wooden window-shutter is often of no use whatsoever ; and when it is required it may be more conveniently and economically disposed of than in huge and expensive boxings, though for any really useful purpose the combination of shutter and roller-blind of metal, recently introduced in London and other of our large towns, on the outsides of windows, is in every respect preferable. It need not be more expensive than the wooden boxings and shutters which it may supersede, whilst it is a secure protection against the burglar, and a safeguard in the event of fire in an opposite building.

Secondly.—As to the means of preventing the spread of fire from building to building, and so to insure against conflagrations.

If the effect contemplated under the first head were fully attained, the necessity of looking further would be precluded ; but inasmuch as the effect referred to cannot be fully secured by any human endeavours, even if the most were done that could be done in every individual case ; and inasmuch, moreover, as all endeavour to induce such effect will be certainly met and successfully resisted by a claim of right in every individual to take care of himself, it is, and it will continue to be, abso-

lutely necessary to compel such a course of action in matters which affect others, as shall secure every man against his neighbour, and the community against any injurious consequences from the freedom of action conceded to every individual in taking care of himself.

Having regard to the security of neighbours and of the neighbourhood against fire originating casually in any building or upon any premises (applying this latter term in its vulgar sense of occupancy), it is necessary to provide that buildings be built so far apart that fire cannot pass from one building to another, or that the exposed parts of buildings not being so far removed from any other building as to be free from all danger of taking fire from it, be so disposed, and be of such materials enclosed and covered, as to render them free from the danger.

No building in or about a town can be said to be wholly free from danger of taking fire from a foreign source, if any part of its enclosures or coverings be susceptible of ignition from sparks or embers. Thatch upon a roof exposes the building which it covers to danger from any fire occurring to windward of it, and tarred felt and pitch-payd wood are substances liable to ignite from very trifling causes ; and as incendial fires cannot be wholly prevented in and about towns, the com-

mon safety seems to require not only the prohibition of any such materials upon or about buildings, both to prevent casualties reaching them and to prevent them from being the means of spreading the danger, but the compelled use of materials which are not so easily ignitable as the substances last referred to.

When the Lyceum Theatre in London was burnt, the author lived in chambers on the east side of Furnival's Inn, a distance from the fire of three-quarters of a mile as the crow flies. Standing upon the roof under which he lived, as a curious spectator of the fire, sparks and embers were brought by the wind, and fell around him in a condition to ignite any such substance as dry thatch.

Nor can a building be considered free from danger accruing to it from a foreign source, if, standing so near to other buildings that flame could under any possible contingency reach it upon any such buildings taking fire, it expose a wooden enclosure or a wooden cornice, turret, dormer, or other appendage, to the fire ; or if it have in its otherwise unflammable enclosure doors or windows made in the usual manner. But heat will cause the ignition of opposite buildings, although actual flame may not reach them ; so that unflammable enclosures, and such enclosures without openings

in them, are essential to every building in a town that is not so far removed from every other building opposite to it, in any direction, as to be beyond the reach of danger from fire in any such building.

It has been already intimated that buildings standing apart or on opposite sides of the same street are dangerous to one another in the event of fire, in a greater or less degree, according to their height and their distance apart. In a street thirty feet wide from house to house, and built up to on both sides with houses not exceeding 30 feet in height from the level of the street, all the houses being supposed to be built of brick, and to have door and window openings with their usual fittings, the houses on one side might under ordinary circumstances take fire and burn without setting fire to those on the opposite side; while there would be danger to the opposite buildings at the same distance apart, if the houses were of greater height, and such danger would increase as the height increased, until fire would be almost certainly communicated to the opposite buildings under almost any circumstances, unless, indeed, the means of extinguishing the fire—which ought never to be counted upon when the prevention of the causes of danger is under consideration—should be at hand. A wind blowing one

way or another, as it regarded the fire and the opposite buildings, and whether the wind were high or low, would of course materially alter the circumstances; but it may be deemed a safe general rule that buildings built substantially with brick or stone enclosing walls, and covered with slates or tiles—the doors and the sash-frames and sashes being the only exposed woodwork—will be in no danger from one another if they are not built to a greater height from the ground between them than a height equal to their distance apart. It must be understood, at the same time, that wooden shop-fronts, and all matters susceptible of ignition attached to the opposed parts of buildings, tend to lessen the security, whilst greater distance apart than a distance equal to the height of the buildings, or of the highest, if they differ in height, on the two sides, by removing the opposite buildings further from one another, lessens the necessity of guarding the enclosures so entirely against susceptibility of fire from without. Again; when buildings stand detached from one another on the same side of a street, and from other buildings rearward, there will generally be required a fence or fences of some kind or other to divide the several occupations; and if such fence or fences be of wood, they are liable to be the means of assisting fire in pass-

ing; and if they are brick or stone walls, they will check it to such an extent as to justify somewhat greater height in the buildings than their distance apart, perhaps to the extent of the height of the fence walls, for although the heat thrown out from the upper windows of a high building on fire throughout, must be much greater than from the corresponding windows of a low building, the materials being the same, it cannot act with so much effect as the heat from the lower windows, which the fence wall is supposed to shut off.

Limited space, and the economical necessity of husbanding it, constantly interfere in towns to prevent the erection of buildings at safe distances from one another as it regards fire, although the all-essential light and air may not be denied to both the buildings fronting to each other over the straitened space because of any possible mischief that one may do to another, and both to the neighbourhood, in the event of fire in any of them. Such circumstances may, however, justify the imposition of stricter rules upon the buildings exposed to them, to render them in the least possible degree susceptible of fire: and whether this be done or not, in all cases of great nearness the necessary openings for light and air in the opposite buildings should be so arranged that the

openings in the one be opposite to piers in the other.

Neighbouring buildings are also exposed to danger from one another by the projections before alluded to, which make the upper stories of the houses to which the projections belong unnecessarily difficult to escape from by the windows in the event of fire. Unless walls of separation be extended so far and be carried up so high as to involve an unnecessary sacrifice of light and air to all parties, additions to houses and attached buildings, adjacent to other buildings, ought, for the protection of such other buildings, as well as for the safety of the inmates of the houses, to be covered with a structure which will confine fire to the building in which it may originate, and so prevent it from attacking the neighbouring buildings by their windows.

In connexion with this part of the subject, may be considered the circumstances which arise when a right of light by a window or windows has been recognised or is possessed by one person over the ground or building of another, and at such distance only within the boundary or from such building, that the building to which the right accrues may be endangered by a fire in any building lying under it. Now the law seems to assume that the adjoining owner has willingly

and for a sufficient consideration conceded the privilege upon the common assumption that silence gives consent, as a certain lapse of time with quiet enjoyment gives a lawful right to the owner of the building with the acquired easement, to retain it. But being lawfully entitled to the opening, he is, or ought to be, entitled to be protected from any danger from buildings upon the ground of the adjoining owner from whom, or over whose land, he has acquired it, although it can come only through such openings; and the State ought perhaps to compel such adjoining owner so to build and so to enclose and cover any building he may have or may erect under the windows of his neighbour, that the building of this latter will be safe from fire if a fire should happen in the building of the adjoining owner. The common safety requires indeed that it should be made imperative upon such adjoining owner so to build that his building shall not communicate fire to another, or collusion between adjoining owners would compromise the safety of a town, as well as endanger their own. If, therefore, no man may be prohibited from granting such an easement to a neighbour as a window or windows in a wall standing up or near to the boundary of the adjoining properties, nor from building up to the boundary under such openings, any man who

grants such an easement ought to be considered to have taken upon himself thereby the consequences which the safety of the community imposes. But he has an alternative to building in a manner possibly inconvenient and expensive, and necessarily of a limited height, and to that he can recur ;—this is, to build so far within his own ground, or away from the wall in which the windows are, that no danger could arise to one of the buildings from the other, in the event of fire in either of them ; and the determination of how far this may be, will lead to the reasonable solution of a difficulty that always interposes itself when it is proposed to require buildings to be built with opposite walls blank or without openings in them towards one another.

The possessor of an easement of the kind just alluded to appeals to the law for protection if his neighbour seek to build up before his window at such a distance only that his light and air by the window will be diminished. But the distance that will conserve to the possessor of the easement his right in that respect will be enough for the safety of the buildings for the purposes herein contemplated, one of them alone having openings in it, and there can be no reason why next neighbours should not be compelled, for the public safety, to maintain that distance between

their respective buildings, having windows in the opposite walls of one or the other, or of both, that the law will enable one of them to require of the other. The law does not, however, extend the same protection to the second builder that the first can obtain from it; the first builder can obtain full protection in the enjoyment of an easement which he may have taken without leave, and which the owner of the next ground could in no other way protect himself against but by raising an obstruction to it, involving trouble and expense that ought not to be thrown upon him. If a man, having land, build a house at, or so near to, the margin of his land, that after a certain lapse of time the next owner may not build up to the margin because of windows in the house first built, the next owner has no power, nevertheless, of preventing himself from being so disabled, but by raising upon the margin of his land an erection of some kind, of the full height of the highest of his neighbour's windows, at whatever cost and at whatever inconvenience to himself. Perhaps the law may be sufficient when applied to the open country, and where a few feet or a few yards of ground, more or less, are of no consequence to the second builder, and he may put his building far enough away from his neighbour's building without loss or inconvenience; but it is very different in towns,

where every foot of land—and, in frontage to streets, every inch—is of value and importance, and it is a mockery to leave the owner upon whom an encroachment of the kind in question is made no easier remedy than the wastefully absurd one which the common law allows him. There are, moreover, so many things which may interpose to prevent the owner of the land encroached upon from acting in his own protection—infancy, coverture, and a thousand other contingencies, not to include absence, ignorance, and poverty, as to render it absolutely necessary for justice' sake, as well as for the protection of the public in towns, that such matters should be specially provided for; and it so happens, again, that the same provision will effect both objects. No man ought to be at liberty to make, or in building to leave, at any level, any opening in the wall of a building standing up to or within such distance of the boundary of his land as to give him any right at law against his neighbour for building at any future time up to the boundary and to any height; and this rule should be made to apply to several buildings built for separate occupation, though upon the same owner's land, so that in protecting private rights the public safety would be secured.

Leaving the subject of openings in the side or end walls of adjacent buildings, it becomes necessary to consider the best means of separating buildings, with a view to protect them from one another in the event of fire occurring in any one of such buildings.

For the sake of wholesomeness, and to prevent damp and premature decay, buildings standing adjacent ought to be built either so close together as to touch, or so far apart that air may circulate between the several adjacent walls, and that access may be obtained to the space between, and to the walls themselves, for the repair and protection of the walls, and on this account the first builder should be compelled in every case either to build up to the margin and limit, and in a true vertical plane, or to keep so far within it that the outside face of his wall should be always accessible from his own ground ; and the adjoining owner should have the like option, losing, of course, if he chose to build up to the margin, all right of access to the outside face of his wall.

But to secure the object now under consideration, — the prevention of the spread of fire from building to building, — it is enough to build between every two buildings one sufficient party-wall which shall be joined on, and give to, and receive assistance from, the other enclosing

walls and the internal cross-walls of the buildings parted by such wall, beginning with those at the lowest level in or upon the ground, extending from outside to outside, at the least, of the fronts and backs or other the returning sides of the buildings; and—unless the roofs of one or the other, or of both, be wholly of incombustible materials—raised above the roofs to some sufficient distance to prevent fire on one side from acting with dangerous effect upon the not fire-proof roof of the other. For the purpose in question it is indifferent whether buildings be thus parted or that each have its own wall, if, in case of a single party-wall being used, the integrity of that wall be fully maintained on both sides. But it is so difficult in practice to prevent the joint owners of a party-wall from dealing with it each as if the wall were wholly his own; and so frequently are party-walls cut into, and even through, by or for one or the other of the joint owners, so as to endanger the other—that restraints are, of necessity, imposed upon both the joint owners of a party-wall for the protection of the other, and of the public; and these restraints are so liable to become a means of annoyance and expense, that it may be fairly questioned whether it is not better for the individual in every case to build his house with all its walls independent of the

walls of his neighbours, so that he may be at liberty to do what may be most convenient to him within his own building, and be free from liability to annoyance from his neighbour. Even in such case, however, the walls which stand in place of the single party-wall must be guarded by the State from abuse by their respective owners, at every point involving danger of fire.

The substance of such side or division walls, whether they be single party-walls common to the two buildings, or two separate walls, ought to be wholly and entirely of such materials only as will, under all circumstances to which they can be exposed, resist the action of fire, and be of such thickness as to be insusceptible of becoming so heated, under any contingencies which can arise, as to communicate fire on one side to any inflammable or otherwise combustible substance on the other side. For this purpose, as before remarked with reference to the sufficiency, in point of structure, of walls of brickwork and masonry, no greater thickness is necessary, under ordinary circumstances, than the safe structure of the building would require, whilst in most cases less thickness of brickwork than the substance requisite to fulfil that object is enough to prevent the spread of fire. It is essential, however, that whenever the external parts of any building are

of inflammable materials, or when the outer enclosures have openings in them close up, or even near, to a party-wall or other wall standing in the place of a party-wall, as between buildings in, or intended for, separate occupation, such party structure should be extended outwards, or upwards, as the case may be, to a sufficient extent to prevent flame from passing before or over it.

The useful effect of a brick wall in stopping the progress of fire, even in a case of conflagration, was forcibly illustrated in a case that occurred in London, in the neighbourhood of St. Katharine's Docks, not long ago. There is a provision in the Metropolitan Buildings Act to the effect that dwelling-houses being in the same occupation, may be united by means of openings through the party wall or walls between them, if, in the opinion of the Official Referees, the stability and security from fire of the houses to be so united will not be endangered by making such openings. Early in 1846 three out of four adjoining houses, extending eastward from a range of warehouses upon the wharf or quay next below the Tower of London, and between St. Katharine's Dock warehouses and the Thames, came into the occupation of the same person. The two easternmost of the three houses were already connected internally with one another, and the owner desiring to unite the third with them, it became the duty of the author of these

pages to survey the premises with reference to the above-stated provision. It appeared upon this survey that the houses, which were of ancient date, had been built with party-walls between them, although imperfect ones,—inasmuch as they did not rise above and separate the roofs,—and that, standing back from the face of the wharf or quay some fifteen or twenty feet, the intervening space had been added to them all;—to some as additions for counting-houses in connexion with the adjacent warehouses, but to the houses in question,—which were public-houses, or rather, which together formed one public-house,—as tap-room below and terrace-flats above, with benches and tables for the delectation of the customers. All these projected additions were of wood, without the intervention of any brick or other wall to serve as a party-wall, so that a fire in any one of these wooden additions must have swept through them all and into the houses from which they were projected, the party-walls of the houses being in fact out-flanked by the wooden additions. Under these circumstances it was suggested to the parties interested, that the westernmost wall of the three houses should be made good, and be extended out to the face of the quay-wall, so as to separate the wooden projection before that third house from the projection before the house next westward of it, as a compensation for removing the parts desired to be removed of the wall between the second and third houses. This was done accordingly, and within a

few months thereafter—that is to say, on the last day of the year—a fire broke out in the warehouses west of the houses referred to, and the wind blowing from the south-west,—notwithstanding the immediate presence and most strenuous exertions of that effective body of men, the London Fire-Brigade, aided by the powerful floating engine, and supplied with water by the Thames,—the fire swept everything before it from Upper Irongate Stairs, next the Tower on the west, to the houses in question on the east, scorching and drawing spalls from the stone-blocking courses of the windowless wall of St. Katharine's Dock warehouse on the other or north side of a thirty-foot road, and it was only stopped by the wall which had been built and made good but a few months before ; up to which the wind drove the fire, but beyond which it did not even scorch the wooden projected additions to the public-house.

If the circumstance which brought about the erection, or rather the extension through the projected additions to the houses, of the party-wall referred to had not happened, or if it had happened twelve or fourteen months earlier, when the *meddling* statute was not in operation, the desired openings would have been made without conditions, and in either of such cases the fire must have swept away the three houses in question with the rest, and as these easternmost houses stand before a load-ing court of the Dock warehouses, to which there are tiers of wooden doors, and stories of

wood-luffered windows in plenty, the Docks could hardly have escaped, as they did escape, except as to the stone-blocking courses and sills of the windowless walls of some of the warehouses, unscathed.

It ought to be carefully provided, moreover, that in case of one owner building or having built his own side or external wall up to the line of demarcation between himself and his neighbour, that the other shall not make use of such wall as the enclosing wall of any building, but that, if he build against it, he shall of necessity build another wall, unless, indeed, the first wall have been built and composed in such manner as to fit it to serve as a party-wall, and its owner consent to its being employed in that character, but not otherwise, even with the consent of the owner of the wall. For although a few inches in thickness of brick or stonework will, under the ordinary circumstances of fire in a building, prevent the fire from communicating itself to such matters as timber or other woodwork on the other side of it, it will not surely do so, because of the imperfect filling up of the joints to which walls are liable; and if there be timber in a wall with a half-brick or other slight thickness only of wall between the timber and similarly combustible matters on the other side, fire in the building on

one side acting upon and through any such timber will almost certainly set fire to whatever will burn that may be in contact with it on the other side.

In the summer of 1846—in the night following Midsummer-day, indeed — some extensive coach-building and other workshops and a saw-mill at the backs of the houses on the north side of Liquorpond-street, London, took fire and were burnt. The eastern boundary of the saw-mill was formed by a lofty brick wall which had been built as a side or external wall, and in which timber had been laid as bond, but in every part, as it appeared, with a half-brick thickness of the wall outside of the timber. Eastward of this wall were the little back-yards of a row of small houses occupied by labouring people, and fronting to a narrow paved court or alley, and every one of these houses had its privy built in the remotest corner of the little yard belonging to it, and against the side-wall of the saw-mill, such wall being employed as the enclosure of the west side of the privy in every case. Between the privies and the backs of the houses were other small erections as wash-houses, forming a connecting link between the workshops and the dwellings, but there were no doors or other ways of communication between the houses and the saw-mill by the yards and through the wall. The fire made its way through the eastern boundary wall, nevertheless; the

heat from the burning bond-timber in the wall, rendered intense by the conflagration raging within the enclosure, set fire to the woodwork of the little privies which abutted upon the wall—the wash-houses took fire from the privies—and out of a row of fifteen or twenty small houses, every one of which contained at least two families, more than half the number were more or less burnt, and the inhabitants of them all were driven from their beds and from their homes. Before the fire was wholly extinguished the writer of these lines saw the effects above stated, together with the broken and damaged articles of furniture, and the bedding and clothing, which had been thrown out of the windows to save them from the fire, and saw also many of the poor people dabbling in the mud upon their own floors in search of whatever more they could save from the ruin that had fallen upon them.

In this case, again, if there had been no timber in the eastern boundary wall of the saw-mill—and none was in the slightest degree necessary to either the structure or the purposes of the wall—the workmen and their families would not have been burnt out of their beds; and if the little privies had been built with properly composed walls of their own against the defective eastern wall of the workshops, they would not have taken fire from the workshops, and consequently could not have communicated fire to the houses with which they were connected. But the "Let-alone" people rail at the meddling which would deal with such things, and

would have it preferred that poor people should still be taxed by their landlords for the means of insuring against loss in the event of fire doing damage to the houses, instead of paying to no greater extent for insuring themselves against loss, in the use of buildings insured by their structure against fire.

It ought, indeed, to be a matter of certainty,—having regard to the reasonable freedom of action which should remain to every one in the use of his house, that he may know, and that the public officer may be assured,—that there is nothing in the wall separating his building from his neighbour's premises, by means of which the effects of an accident by fire on his neighbour's side could be communicated to him.

It must happen at times, and it is indeed of frequent occurrence in our older towns, that buildings, the property of different owners, used and occupied by different persons for different purposes, are intermixed horizontally, so that stories or parts of stories of one building run into and occupy portions of the space that would seem, having regard to the site or soil, to belong to another. In such cases the safety of the public requires either an equitable adjustment of the rights of the several owners, so as to confine the building of every separate owner to its own site

or soil,—and this should be made whenever rebuilding renders it easy to make it,—or that all such intermixed property should be separated by structure, equivalent, as it regards power of stopping fire, to a party-wall, disposed horizontally above and below the intermixed parts.

In like manner with buildings over public ways; inasmuch as public ways lead, of necessity, to and from places to which the public have right of access, and generally to inhabited localities, it is necessary that any public way leading through and either under or over any part of a building should be rendered safe to the public under any contingency, and consequently that any building built over or under a public way should be under special charge for the public, and be made wholly, and most effectively, fire-proof, as well as certainly safe in respect of its structure. But inasmuch as the building over a public way is a restraint of both light and air, no occasion of the demolition of any such building should be allowed to pass without making provision for the resumption of the space above, as well as for the preservation of the right of way below, and so that the way be not again built over.

When right to light and air, by window or other openings, has been given to or acquired by the owner of one building over the building of

another, it becomes necessary, as before intimated, either to require the possessor of the privilege to abandon it, and stop up the openings, or to compel the owner of the adjoining land to build at a safe distance, as it regards fire, from the building in which the openings are; or so to build upon his land that, not invading his neighbour's rights, the building of each shall be safe from that of the other in the event of fire.

But in crowded localities, and where every such privilege as that alluded to is essential to the wholesomeness as well as to the economical use of buildings, and where consequently every inch of ground is of great value to the owner of the land, or of the building, to the detriment of which the privilege in favour of the other exists, the party building ought to be required to do what may be necessary to keep fire out of whatever building he may erect, and to prevent fire from getting from any such building into his neighbour's building by or through any openings in the wall between the sites. To this effect it may be necessary to compel the formation of horizontal fire-proof structure in such cases, to compensate for the defect in the party-wall.

It is not as between owner and owner alone, however, that the last-indicated precaution ought to be required, but as between any owner and

the public when the circumstances are such as to require it. Nothing is more common in our large commercial, manufacturing, and shop-keeping towns—London, the largest, being essentially of the last-mentioned description—than for shop-keepers to go on adding house to house—building to building—until the united areas may be measured by roods and poles, and in some cases almost by acres and roods rather than by squares and feet. In such cases it is absolutely essential for the public safety that something more than mere party-walls at the remote borders of such occupancies be required. Warehouses in which inflammable goods are stored in large quantities, and shop-houses in which, whether under the name of shops or warehouses, goods of merely combustible character are distributed, though the quantities be not so great as they may be in storing or deposit warehouses, ought to be inter-divided by walls, or be otherwise formed in compartments by sufficient structural separations to prevent any fire that may happen from becoming of ungovernable extent and thereby to endanger the neighbourhood.

A wholesale shop or distributing warehouse of the kind commonly known in London as a Manchester warehouse, being for the sale in bales and pieces of Manchester and other manufactured

cotton, linen, and silk goods, situated near the west end of the Guildhall, London, was burnt in the summer of 1845. It consisted of one house and part of another fronting to Aldermanbury, and of one house rearward of those two, which had been separated from them by a wide open space, but which space had been covered in and so added to the houses east and west of it for the purposes of the shop. Any internal walls, though with doors in them, or a floor and roof of fire-proof structure to and over the formerly open space between the front and back houses, would have at least delayed the fire, and so diminished its dangerous character as it regards the neighbourhood; but there were no such things, and in one short hour more than one hundred thousand pounds worth of property upon the site was destroyed, all the surrounding buildings were more or less damaged, the Guildhall included, and the fire was with great difficulty prevented from taking hold of the premises southward, which had windows looking into the formerly open space. The immediate presence of the Fire-Engine Establishment from its head-quarters in Watling Street close by, and the accident (it must be called) of a ready and plentiful supply of water in the mains, limited the ravages of the fire to the immediate locality in which it broke out. It has been estimated, however, that there was within reach of danger, that is to say, within a hundred and fifty yards from the site of the fire, property taken together worth a million of money, so exposed to the danger from the connexion and character of

the buildings in which it lay, that under any less favourable circumstances than those referred to it must have been all destroyed.

But it is not property alone that is endangered in such cases, for if the fire in Aldermanbury had remained undiscovered one or two hours longer, the scores of shopmen, domestic servants, and other persons who lived on the premises would have been in bed in the upper rooms of the houses which were burnt, and from the situation of the premises, and the arrangements always made in such places for limiting the means of ingress and egress, in all probability a large proportion of them would have perished in the flames.

In the same neighbourhood, however, and within reach of the danger which the favourable circumstances shut off, and at about the time the fire happened in Aldermanbury, another wholesale shopkeeper of the same class, and the upper stories of whose shop are occupied in like manner by the shopmen and domestics, added another house to the houses already united in his occupation, for the purposes of trade below and of residence above, and successfully resisted the requirements of the statute for the protection of life and property, upon the plea that the houses were not dwelling-houses but warehouses! the local magistrates, upon whom the enforcement of the law devolves, admitting the plea, and leaving the inhabitants of the *warehouses* to their fate, if an over-heated stove-pipe, or any other of the many contingencies which occasion fire in such buildings, should

produce its effect, and the effect not discover itself until they are helplessly asleep over the well-fueled furnace below.

Warehouses proper, or storing warehouses, in which goods are laid up in bulk, and as closely packed almost as in the hold of a ship, but less safely because of the gangways or passages which must be left in warehouses between the heaped-up goods, both as a means of laying them up, and of removing them, and which give access of air to feed combustion if the goods take fire, require to be considered with reference to their structure as buildings, individually, as well as to their separation from one another, or from other buildings, as a means of preventing the spread of fire from building to building, because of the practical difficulties of dealing with such buildings so occupied, when on fire, so as to subdue the fire. The difficulties arise from the physical incapacity of men to go near enough to the fire to apply water with advantage ; and from the little effect produced by even the largest quantities of water that can be brought to bear upon such huge bodies of burning matter as warehouses of the kind, and under the circumstances contemplated, present. For such warehouses, limitation of the capacity of individual warehouses, or the dividing the same warehouses into compartments by walls

which shall be capable of resisting the action of a fire of the intensest heat, of temporary duration—as all merely incendial fires must be, for they soon burn out—is almost essential to the safety of any neighbourhood in a town in which warehouses, used as above contemplated, are placed. What the limit of capacity of the building, or of the compartments of a divided building, ought to be, will depend upon the considerations of height and area ;—a greater capacity being admissible if the height be within the control of fire-engines of such moderate power as to be convenient for general use in a town, than if the warehouse be carried up to such a height above the street or other site from which a fire in the building must be acted upon, that the head of any fire in it cannot be reached from such level, because fire which is beyond reach of, and cannot be controlled by, the usual means, is liable to be communicated to buildings and other ignitable bodies beyond the buildings, through the agency of the wind ; party-walls being wholly insufficient in such cases as a means of preventing the spread of fire beyond the building in which it may have originated.

Warehouses intended to be used, or, indeed, liable to be used, for storing goods of a combustible nature in bulk, as cotton is stored, and most especially of such kinds as are liable, under any

circumstances, as cotton seems to be under some circumstances, to spontaneous combustion, ought to be built wholly fire-proof as to their structure, so that fire in a lower story shall not necessarily be communicated throughout the whole height of the building; and be built also of such limited extent laterally, or so divided into compartments laterally, that no fire occurring in it can acquire volume and power beyond the means certainly available in the town or neighbourhood, of controlling it, having regard to supplies of water as well as of engines, and of the means of working engines with effect. Moreover all warehouses so intended, or liable as above, built near to any dock or harbour for shipping, in and about, or out of which vessels cannot be easily hauled out of the way at the shortest notice, ought to be wholly of fire-proof construction when their height is great, and to have fire-proof roofs, whatever their height.

Inasmuch, however, as a very large proportion of the goods required to be stored in warehouses are either not of a combustible character, or, if combustible, are not liable to be stored in very large quantities at the same time, and within the same buildings, or even within buildings at all—as is the case with timber to a large extent—nor are all goods which are of a combustible character liable, under any circumstance, either to sponta-

neous combustion, or to ignition from slight causes, it may be more properly, perhaps, considered as a matter of police than of buildings' regulation, what use or uses of a warehouse shall make it necessary to render the building wholly or partially fire-proof, and to restrain it as it regards either height or area. Supposing any incombustible substance to become an article of commerce as extensively employed as wool is, it would be manifestly absurd to require that substance to be stored with those precautions which are but reasonable in storing wool in bulk; and in like manner wool may be prudently stored in places in which it would be most imprudent to lay up raw cotton, having regard to the liability of the articles, respectively, to take fire, and to feed combustion in the event of fire. It will be for the owners of such buildings as warehouses, to determine for themselves, whether to build them so as to be fitted for storing goods of such character, or in such quantities, as to render them liable to suspicion and to be subject to police regulation; or to build them in such manner that goods of suspicious character may not be laid up in them; and it will be enough in this place to show by what process buildings may be built so as to be safe against the action of fire within themselves,

and to afford the best protection to the neighbourhood of the buildings, against any fire that may happen in them, and to indicate what general rule as to limit of capacity may be a reasonable protection to the public in the case of any such buildings, not rendered proof against the action of an incendial fire in them.

There is no kind of economical structure that resists the action of fire so perfectly as brickwork does, and any structure wholly of bricks, set in and combined with proper mortar, may be deemed for all economical purposes a fire-proof structure. But floors and roofs, or roof coverings, cannot be formed in brickwork alone, without the sacrifice of space and materials, to so large an extent as to render such a mode of structure inconsistent with a due regard to economy in those important particulars. Means are to be sought, therefore, by which brickwork may be rendered available, to the greatest extent possible, consistently with economy of space, and, if it may be, of materials also. For this purpose iron presents itself as a substance wholly incombustible, and capable, in the form of beams and girders, of bearing over space horizontally, and so as to leave, for economical purposes, a large proportion of extent in height, which brick vaulting would absorb; and requiring no such absorption of space

as brick vaults require for their lateral abutments, iron, employed as a means of vertical support, in columns or story-posts, will give the requisite strength to that effect in far less space within an enclosure than brickwork requires in piers or pillars to give the requisite bed to the springings of vaults, and to carry the weight of brick vaulting. But iron, although incombustible, is fusible under the action of intense heat, and is, in its more economical condition, frangible if suddenly cooled when hot; without reference to its generally brittle character, or to the uncertainty which attends its manufacture, when applied in that condition. Beams, girders, and columns or story-posts, of wrought-iron, if such things could be produced in wrought-iron economically, would bend when exposed to a high degree of heat, and let down any structure that had been made dependent upon them; whilst beams or girders of cast-iron break when dashed with water; and columns of the same substance are liable to soften and yield, as well as to snap; in either and in any case, involving the ruin of the buildings, the destruction of the property confided to them, and danger to the lives of firemen or others within reach of the ruin.

So great is the danger apprehended from the treachery of cast-iron in buildings on fire, that

the men of the London Fire-Engine Establishment, who go unhesitatingly, in the execution of their duty, into burning buildings, are prohibited from going into parts or places which depend upon supports of cast-iron, whilst they are allowed to trust themselves to burning timber almost at their own discretion—a quality for which they are not, indeed, so remarkable as they are for headlong and gallant daring.

Cast-iron is constantly recurred to, nevertheless, as a means of economizing space in the formation, and largely also in the support of the floors of buildings which it is desired to render proof against fire; and it is certain that the use of beams, girders, and story-posts of cast-iron tends to that effect: that is to say, the liability of the building to take fire is lessened by the use of iron in place of wood, but for the purpose under consideration—power of resisting the action of fire when it occurs to matters stored in a building, and is fed by such matters independently of the substances employed in the structure of the building—iron requires to be itself protected from the action of the fire.

The common practice to this effect, when it is attempted at all, is to turn flat arches in brickwork from girder to girder, or when the floor is formed, from binder to binder; the girders being the main bearing-beams, and extending

from wall to wall, and the binders short beams extending from girder to girder, and just so far apart that brick arches of slight curvature may be trusted to bear from one binder to another; and cast-iron columns are used as means of giving whatever intermediate support may be required to the girders, whose ends commonly run into and bear upon the enclosing walls.

This mode of structure applied to the floors renders a building, to a large extent, proof against fire, and most kinds of goods will remain safe and uninjured for a time upon an upper floor of a building whose floors are so formed, even if fire rage in a story below, so that flame and heated air be not allowed to pass up by any well-hole, or other opening, or by stairs or other means of communication from the lower to the upper stories. But this mode of structure requires that the beams, whether girders or binders, between which the brick arches are turned, shall restrain the thrust of the flat brick arch, without carrying it out to the enclosing walls, which might be forced out thereby; and to enable them to do so, wrought-iron tie-rods are used to hold the beams together under the pressure of the arches, or rather, to be to the arches as a string to a bow, to prevent them from opening, and so from acting upon the beams. But these all-

important tie-rods lengthen as they become heated, and the beams thus, in case of fire, lose their aid in resisting the arches, yield, and perhaps snap across, and the floor is gone. Moreover the cast-iron girders and binders of a floor formed with brick arches are not wholly protected from the action of any fire below them, and becoming, therefrom, unequally heated, and consequently expanding unequally, they are exposed to danger of yielding from that cause, as well as from any appliance of water; whilst the cast-iron columns or story-posts, in any story of which the contents may burn so as to produce intense heat, are rendered thereby most precarious as supports, whilst not alone the floor next above, but all the superstructure depends upon them.

A floor wholly proof against fire, that is to say, a merely incendial fire, may nevertheless be formed upon cast-iron girders and binders by a process different from that last described as the mode commonly employed, and at no appreciable sacrifice of room, inasmuch as the available height in a story of a warehouse cannot be greater than to the under side or soffit of the girders of the floor above.

Let the binders be made of the full depth of the girders, opening them between the top and bottom flanges, not to waste metal. Form an

open floor of slight cast-iron batten-like bars about three inches wide and three-eighths of an inch thick, and having their ends turned up and out to form a shoulder and a bearing lip, by which the bars may rest upon the lower flanges of the binders, and bring their own under-faces slightly below the level of the soffits of the girders and binders, and laid fully their own width apart. Raise a boarded table or platform, like a large mortar-board, up nearly to the under side of this open iron floor, and give it temporary support, adjusting its upper face at an inch and a quarter, or thereabouts, below the soffits of the girders and binders, and about an inch clear from the under sides of the bar-battens, having first strewed a little dry sand over the surface of the board to prevent mortar from sticking to it, as a brickmaker does to his mould in moulding bricks. Then fill in from above to a thickness of not less than three inches from the top of the board with mortar, gauged with plaster so that it may set without waste of time. The mortar should be made to pass in under the whole of the ironwork—girders, binders, and bar-battens—and to cover these last and the flanges of the girders and binders to the same depth as the surface of the board is below their soffits, and so indeed as to form one uninterrupted slab of about three inches in thickness to the extent in

area of the board of plaster composition as a ceiling to the story below, hung up to the girders and binders by the open iron bar-battens which are incorporated with the slab of plaster composition by the process. A few hours, or a day or two, according to the manner in which the mortar may have been prepared, and to its consistence, and, in some degree certainly, to the weather and the time of the year, will allow the plastering to set so as to allow of the removal of the board, which may then be applied to another and adjoining compartment, and so on until the whole extent of any ceiling shall have been completed. With a sufficient stock of what may be termed form-boards adjusted side by side and end to end closely, the ceiling of any story may of course be made complete at once, and with advantage, as there would be no joinings. Under any circumstances, however, the boards should be so adjusted that the joints should not occur under either girders or binders, where the plastering will always have the longest space to bear across.*

* The process above described will be at once recognised as an adaptation of that described in a former page as employed in Paris in the formation of the massive and fire-proof ceiling so common there in all modern buildings—thin iron bars taking the place of the batten-lath, and being laid with turned-up ends upon the bottom flanges of the girders and binders, instead of being nailed up from below.

The ceiling having been formed in any part, the floor above is to be made of tiles of the same substance and character as bricks, that is to say, of plain tiles, or of similar tiles made for the purpose, of about the same size as plain tiles, laid in two, three, or four thicknesses, having reference to the bearing from binder to binder—to the necessity for the purposes of the warehouse of a boarded floor over the tile-formed floor, which may discharge the latter of immediate wear and tear, or—if the tile floor is to serve the purpose of the floor above—to the bearing, and to the concussions to which it would be exposed in use. For a bearing of not more than thirty inches from centre to centre of binders, three thicknesses of plain tiles will be enough for any floor upon which in use nothing may be thrown down more likely to induce fracture than bags of cotton or packs of wool, whilst four thicknesses will be enough for almost anything, if the materials be good and the work well executed. The mode of execution is as follows :—A sailing course of bricks should be prepared in the line of the surface of the girders and binders as a ledge upon which to rest the edges of the tile floor, and by means of which to make an indestructible bed-joint of mortar between the floor and the walls, and tiles are then to be laid in one thick-

ness from binder to binder—receiving temporary support from a straight-edged batten or anything of that kind, capable of being withdrawn as the work proceeds—dry or without mortar or other setting, upon the girders and binders, and so forming, in fact, a loose floor. Upon these loosely laid tiles a thin layer of strong cement, such as that known as Parker's Roman Cement, is spread, and another course of tiles is then carefully rubbed down upon the cement, taking care to break joint in every direction with the tiles of the first course, and by the rubbing down to fill the joints of both courses, as well as to bed the upper upon the lower course perfectly. A third and a fourth course, if need be, bedded and rubbed down in like manner, will give a floor of the required strength in any case, and capable of resisting for a sufficient time the action of any fire that can be made upon it, after it has become once thoroughly set and dry.

Thus the iron structure would be protected from the action of fire both above and below, and be free to expand and contract between the two bodies—the plaster ceiling below, and the tile floor above—without injury to either; whilst those two bodies would effectually resist the action of fire, as long as any incendial fire above or below them could find matter with which to keep itself alive.

The mortar of the ceiling would readily allow the flanges of the girders and binders to detach themselves as they expanded and contracted, whilst the iron bar-battens encased in the plaster would not be either long enough or bulky enough for any alteration of their form by the heat to derange the plaster: airholes by gratings through the external walls might permit a current of external air to pass freely through between the girders and among the binders in every bay, and so to prevent the tiled floor above from retaining damp under any circumstances, and to carry off heat from a fire below, so that it might not by any possibility be communicated to whatever may be upon the floor above; the floor and ceiling contemplated being fully trustworthy as means of preventing the current of air intended to keep the iron castings from becoming heated, in the event of fire in the building, from gaining access to the goods above and below them, to feed the fire.*

For such a floor the binders must be of more frequent recurrence certainly; that is to say, the

* It is, moreover, well worthy of inquiry whether, with the arrangement above suggested for protecting it from the action of fire, timber might not be used for the structure of a floor, in many cases in which prudence would otherwise prohibit the use of that material, because of its liability to burn when exposed without protection to an incendial fire, though it may be in every other respect preferable to iron.

bays must be narrower than they are usually made when brick arches are employed in bearing over the void, but inasmuch as the girders and binders must be made deeper as the span of the arches is greater, to admit of the sufficient curvature or rise of the arches, and as the weight of brick arches and concrete filling-in to the spandrels is greater than the tile floor and plaster ceiling would be, the depth of the bearing beams need not be so great for the latter as for the former, whilst tie-rods would be wholly avoided, and probably the expense of a floor in the manner proposed would be less than the expense of a floor of the kind in use.

Whether such a mode of forming fire-proof floors be adopted or not, it is certain that in no case of the kind which it is desired to provide for, should iron columns or story-posts be used to carry the floors. The space necessary for brick piers ought for safety's sake to be given up; and this need not really be much more than iron columns of sufficient strength would occupy, if care be taken in the selection of bricks and in building the piers. A 2-brick pier, well and truly built of what in London are called pavours, or even of Dutch clinkers, set in a well-compounded mortar, will carry safely almost any weight that can be imposed upon it; and for the upper stories

of most warehouses a similar pier of $1\frac{1}{2}$ -brick square would be enough, taking care merely to deposit and take up again the weight through the agency of iron plates, which may be either wrought or cast,—as their services in the position of cap and base plates would require no service which the metal in any state short of fusion could not perform ; whilst any possible danger to slight brick piers from heavy bodies in motion in a warehouse, may be guarded against by quoin fenders of timber, so to discharge any blow in the manner that upright fenders of timber against the faces of wharf and quay walls prevent the walls from being injured by craft striking against them ; the burning out of the proposed quoin fenders in case of fire being a matter of no consequence whatever to the structure.

An excellent mortar for resisting the action of fire, and proper to be employed in building any such slight brick piers as substitutes for, or instead of employing, iron columns, may be made of pozzolano mixed with fresh-ground lime of chalk from the lower beds ; and as real pozzolano is an imported substance, and likely to be expensive, its place may be very well supplied by an artificial substance of similar character, produced by burning any marly clay that is fit for brick-making to a grey clinker, and reducing such clinker to a

grain of the size of coarse sand. Three-fourths of this substance to one-fourth of fresh-ground lime, mixed dry in the first instance, and when so mixed, rendered plastic by the addition of soft water, will yield a mortar capable of resisting fire for a long time, and water, if need be, as long as any bricks that can be set in it. The same mortar would be excellent, if time can be allowed for the setting as the work goes on, for ceilings as last herein described, but care must be taken in using it for such purpose to guard against the consequences of its expansion in setting.*

* In submitting suggestions for the formation of fire-proof floors for warehouses,—to the limitation of fire in which the above-stated observations are mainly addressed,—the author desires to guard himself from being held answerable for the failure of any attempts to execute a floor upon so slight a description as can be given in a work of this kind, of the requisite disposition of the materials, and of the processes proposed to be employed:—he has not written a specification from which any attempt ought to be made to execute any such work, and especially by persons not conversant with the processes. At the same time the author does not profess to have made any invention or any discovery, but simply to have suggested a combination of processes, all of which are of common practice in various places, but which have not, so far as he knows, been at any time brought together, either in the manner or to the effect contemplated. It will, perhaps, be readily understood that such a floor, if found to be well adapted to protect goods in warehouses, would be available in museums, libraries, and other buildings made the depositories of contents so valuable as to render their protection from the ravages of fire a matter of consideration.

Fire-proof stairs enclosed in brick walls having double iron-doors in the doorways through them to the warerooms—openings in the enclosing walls as few as are consistent with the essential use of the buildings as storing warehouses—and the closing of such openings by means capable of shutting out currents of air as well as of preventing access of fire from other buildings or things,—are all obvious precautions to be regarded according to the hazard attending the particular articles to be warehoused when laid up in bulk, and to the danger to which the neighbourhood may be exposed from their combustion.

Perhaps, however, the utmost that can be imposed by authority is, that warehouses used at any time for storing goods of a combustible nature in bulk, may not exceed a certain capacity. And with regard to any such imposition, experience seems to have determined that, if a warehouse much exceed forty squares in area and fifty feet high, and, being filled with combustible goods, take fire, and the fire gain full effect before it is checked, the height and power of the fire place it beyond control, and render it dangerous to the neighbourhood, although it may not pass beyond the lateral bounds of the building. Height in such a case is found to be the more difficult extreme to deal with, and it becomes necessary,

therefore, as height is increased, to lessen the bulk by diminishing the area ; and, on the other hand, low buildings, under the circumstances supposed, may be extended in area without increasing the danger in the event of fire. Thus 200,000 cubic feet has been arrived at as the largest capacity of which any single warehouse, or severed compartment in a series of warehouses, should be permitted. This may, of course, be properly susceptible of relaxation, if the construction employed in any case be such as to confine any fire that may occur, to one story of the building ; or, if the purposes for which the building is to be employed are such as to render the restriction as to capacity unnecessary, or if, indeed, the precautions taken in other respects be such as to mitigate the evil to be apprehended in the event of accident : it being understood that the assumed limit of permissible capacity of a warehouse above stated is upon the assumption that it is built of brick or of stone, as to its enclosing walls, and of timber, as to its floors and other internal divisions.

It is but proper to observe upon this, nevertheless, that the London Fire-Assurance Offices do not allow a capacity of 100,000 cubic feet to be exceeded in any warehouse built as last indicated, without an addition of 50 per cent. to the rate of assurance, both as it regards the building

and its contents, whilst for the so-called Manchester warehouses, or wholesale distributing shops, they are understood to require special rates—having reference to capacity and to the circumstances of the buildings—of three and four times the amount charged for the assurance of buildings and goods in warehouses, properly so called, and built as required by the Metropolitan Buildings Act. The Table of conditions which affect the rates of assurance of buildings and goods in London, when the buildings are of the Manchester warehouse kind, is an index of the results of the experience acquired by the Assurance Offices as to the risks attending them, and a copy of the Table as re-arranged by the Associated Offices in London to that effect in November, 1845, is appended hereto (see Appendix, No. I.) ; for the purpose of illustrating the importance to the public, of the character of the buildings through which goods of certain sorts pass in course of transit from the manufacturer to the consumer. The illustration will not be complete, however, unless it be also stated that the London rates are low, in comparison with those charged at Liverpool upon the same goods in the raw form, or in their way from the producer to the manufacturer, and that the principal reason for the difference is, that the long-continued operation of regulating statutes, as it regards the buildings of the Metropolis, does, to a large extent, prevent incendiary fires from becoming conflagrations. Hence it is that whilst special rates for the most dangerous part of London have not exceeded 10s.

or 12*s.* per cent., enormous as these are compared with the ordinary rates of 2*s.* and 3*s.* for goods in but very moderately secure buildings, special rates have been charged and, of necessity, paid, for the assurance of goods and buildings in Liverpool, ranging from a minimum of 8*s.* up to 30*s.*, 35*s.*, and even in some instances to 45*s.* per cent. per annum! And let it not be forgotten that the merchant, the manufacturer, and the shopkeeper, who pay these rates of insurance, charge them upon the goods before they add their own profit, so that they exist in the price of every yard of cotton, linen, or woollen cloth,—of every pair of stockings,—and of every skein of thread—of which the materials have passed in any form through buildings dangerous in respect of, or rather, not secure against fire; and these, by their preponderance, affecting the market, the high rates of insurance tell upon everything of the kind whether it have so passed or not; whilst it may be confidently asserted, that the difference in the cost of secure and insecure buildings—involving the lowest and the highest rates of assurance respectively—need not, under any circumstances, amount to an appreciable rate per cent. on the goods which pass through the storing warehouses of Liverpool and the distributing warehouses of London.

But, as before remarked, it must still be left to individual owners to build warehouses as they please, within some such scanty restrictions for

the public safety as those last indicated, as to the limitation of capacity within the same walls, and as to the matter and manner of the walls; though it might with great propriety surely be made a matter of police regulation as to the uses, having regard to the nature and character of the goods to be stored, and to the circumstances of the locality and neighbourhood. Enclosed and covered buildings are often built for one purpose, and at once applied to another, without question on the part of their owners as to the fitness of the buildings for such other purpose. Such conversions or altered uses may not result in mischief, and yet danger may be involved. The police may not be the proper judges in such cases, perhaps; but it is by police regulation alone that the cases can be brought out, and in such manner that the danger may be ascertained and prevented. A man builds a warehouse for storing goods generally, and at once fills it with corn, which bursts the walls and brings danger to the public, discredit to the builder, and loss to the owner; but it would be wild to require from the public, therefore, that every warehouse should be built with such thick walls, or in such shallow stories, that it may serve for storing corn as a granary, liable to be filled in every story like the hold of a ship. And in like manner, as it re-

guards goods dangerous in respect of fire, and by the combustion of which in combustible buildings the public safety may be endangered, and waste of the nation's resources induced.

It appears from an estimate appended to a Report by Mr. Fairbairn on the Construction of Fire-proof Buildings, with Introductory Remarks by Mr. Samuel Holmes, published at Liverpool in 1844, that the insurance-offices paid for losses by fire in Liverpool alone, in the ten years ending December, 1842, the sum of 1,121,427*l*. This sum does not, of course, include the losses of, and other injuries to, the poor who do not insure, but who are always great sufferers in cases of fire; and some of the fires which occasioned the losses were extensive conflagrations, in which lives were lost in the attempts made to subdue the fire; nor does it include a probably large amount of property not sufficiently insured to cover the losses.

Urged by successive calamities by fire, and by the high rates of premium which the insurance offices were compelled to exact to enable them to meet the losses, the people of Liverpool applied to Parliament at length, and obtained, in 1843, an Act to compel themselves to abide by certain wholesome regulations, as it regarded the security of buildings from fire. The effect of this Act, 6 & 7 Vict. c. 109, and the provision of a supply of water available in case of fire, has been to reduce the rates of insurance considerably; but the pro-

protective measures are estimated to have cost from 200,000*l.* to 300,000*l.*, which being added to the losses above stated, with a trifling addition for the losses not included in the estimate, will show an annihilation of property in one town alone, and within ten short years, to the enormous amount of a million and a half of money.

DRAINAGE AND VENTILATION.

No building can be really wholesome that is not both well drained and properly ventilated, and one essential condition to the thoroughly wholesome ventilation of a building is, that its drains be themselves efficiently ventilated. But drains require to be scoured also, in order that more may not devolve upon the process of ventilation than is absolutely necessary, and that any process of ventilation applied to the building drained may not be rendered ineffectual to the real purposes of drainage and ventilation. Having regard to these considerations, it will be convenient to treat of drainage and ventilation as two distinct subjects, how closely soever they may be connected in their effects, or rather, how closely soever they are brought together by the necessity that they should co-exist. It will be found that the means necessary to the perfect drainage of buildings will result in the ventilation of the buildings to the extent of removing the foul air to which they are exposed from their drains; and it will appear—what may be evident per-

haps without being pointed out—that a town or other inhabited locality will be properly drained and fully ventilated if the buildings in or upon it be so; the drainage and ventilation of every town being in fact the drainage and ventilation of the buildings comprising it, and consequently a site occupied by buildings may be well drained in one sense of the term, and open to access of wholesome air, and be neither drained nor ventilated in the proper meaning of the terms as applied to towns. Hence it is that fever and other consequences or contingencies of foul air in inhabited localities may prevail upon hill-side and sea-side, and towns in inland valleys be free from those evils.

DRAINAGE as applied to buildings must be understood to imply not merely the removal of superfluous water from the building and the site about it, but the removal in a fluid form, by sub-drains, of all matters soluble in water, or capable of being held in suspension in water, so as to be carried off without greater mechanical force than the available current of back-water, in any case, will afford without leaving deposits in the drains; that is to say, of all such matters as are offensive to any sense, or capable, under any circumstances to which they may be exposed, of causing annoyance or injury; and further, the

removal of all such matters by sub-drains, so arranged, applied, and connected, as to give no offence and cause no injury in course of removal.

VENTILATION, as applied to buildings, must be understood to imply both the means of admitting and of compelling the entrance of fresh air, and the means of escape, and of compelling the exit, of spent or otherwise foul air from any building, and from the several apartments into which a building may be divided. But inasmuch as any process which would have the effect of removing or compelling the exit of air in any condition would compel the entrance of air from some source or other, if a way be made for it, the apparently complex means necessary to ventilation resolve themselves into a provision for admitting fresh air in an agreeable state or in a condition to be made agreeable, and of a provision for the removal of air which is from any cause unwholesome or otherwise injurious or offensive.

THE DRAINAGE OF BUILDINGS.

THE first essential requisite to the drainage of a town or other inhabited locality consists in the means of disposing of the collected soilage to such effect that a flux, comparatively innocuous

while spread over the whole surface, do not become a concentrated virus certain to endanger the parts upon which it may be thrown, and capable of endangering the whole system.

Sunderland, which claims to rank among the sea-port towns of England as the first ship-building port, and as the fourth sea-port town by the extent of its commerce, is wholly undrained in the proper sense of the term—that is to say, as to its buildings; and it is besides, in common with very many more of our large towns, in the north of England especially, almost wholly unprovided with privies, as means of retaining and shutting out from sight those matters which perfect drainage would lead away and remove without delay. As a consequence of such privation, the sweepings of the streets, courts, and alleys, in which the habitations of the less cleanly of the population occur, include human ordure with the garbage and other filth which are sure to be thrown into the streets when no readier means of getting rid of such matters are at hand. These sweepings are at Sunderland deposited close to the parish church-yard, which is on high ground, and south-west of the most densely populated part of the whole town, and there the deposits lie, festering and stinking, sometimes in greater quantities, and sometimes in less, as the demand may be for manure, and as the supply from the streets may be affected by scouring showers of rain.

It was at Sunderland that the cholera first

made its appearance in England at the time of that awful visitation in 1831-32, and Sunderland, like London, is in fact in no better condition now than it was at that time, with reference to the threatened return of the pest. (See Appendix III.)

London, which claims to be the first, and the best sewered, city in the world, is surrounded on all sides, and in some parts is seamed, with open ditches, stagnant with filth from its boasted drains and sewers. The pleasant suburb and village of Hampstead sends the filth which is not retained in its cesspools into an almost stagnant open ditch, which meanders through the fields along the back of Kentish Town, and through a new quarter of the town on that side. Bayswater brook still leads much of the stench, if not of the filth, of the palace-pretending Paddington in a steaming state into the ornamental waters of Kensington Gardens and Hyde Park; whilst Earl's Court and Brompton are seamed with sewer ditches, as foul as, and more stagnant than, the sluggish channel of Hackney brook, where this latter receives the soil of Stoke Newington and Clapton, and as it meanders through Hackney and Homerton to the marshes and the river Lea. On the Surrey side the long and low levels make the case worse, if worse can be; the least noisome of the open sewer ditches of the Lambeth, Southwark, and Bermondsey district, being the open sluggish and stinking ditch which skirts the road from the foot of Brixton hill to Kennington church,

and crossing through South Lambeth, opens into the Thames by the ancient site of the South London water-works, now more appropriately occupied, as it regards the sewer ditch, by some gas-works.

Recent inquiries, and to some extent experiments, have determined that the removal of the soilage of towns need no longer be an impediment to their thorough drainage, inasmuch as the soilage may be made, under some circumstances, to pay at least the cost of its own removal, when it has been collected, even if it may not be expected to bear the cost of collecting; the collection being the leading of the soilage by a system of main drains and sewers from its sources to convenient places of discharge, where it may be taken up, and from whence it may be distributed in an inoffensive condition as manure. Hitherto the sea, a river, or other body or stream of water, according to the situation of a town with regard to any of these, has been deemed an essential adjunct to any system of town drainage as a means of dissipating the contents of the sewers of the town after they shall have been collected; but, except in the case of rapidly-running watercourses, well supplied at all times with water, the contents of sewers emptied into an inland water are liable to occasion annoyance, if not injury, by the deposit

upon the banks of the fouler unsolved matters which they bring, and by the exhalations from them, whether they deposit the filth or not ; whilst tidal rivers, and even the sea, cannot always be used with certain effect, unless the sewers are made to discharge below low-tide level.

The inhabitants of, and the visitors to, many of our sea-side watering-places are often exposed to annoyance, and sometimes to injury, from the discharge of the town drainage upon the much frequented sea-beach. Cast-iron mains are commonly used at these places to conduct the soilage from the sewers and drains a little way out from the land, and these are commonly allowed to terminate at half-tide level or thereabouts, so that they are for half their time discharging noisome and pestilential streams under the nostrils of those who betake themselves to the beach for air and exercise. But ladies, with books or with needlework, and nurses with their charges, are apt to resort to the propped up and clean-looking round iron pipes for the convenience they offer as seats ; and as they sit, they, and the children who play about them, inhale the poisonous gases which the soilage of the town emits, and many a family returns inland from the sea-side fevered with the stench at the sea-beach, rather than invigorated by the sea-breezes. A few years ago the writer of these lines brought his family home to London, after a six weeks' residence at a sea-side watering-place, with all his children

ill, and one of them seriously so, with fever, which resulted in the measles, brought on, he then believed, and still considers, by the cause alluded to. There were some of the town sewer pipes running out to half-tide distance in the most accessible part of the beach, and upon some of these his children's nurse would seat herself day by day with the baby on her lap, and with the elder children playing about her, and with the children of other families similarly exposed to the same danger.

The efficient scour with water, diluting thereby the soilage in its way, and the ventilation of drains and sewers, would go far to remove all danger as well as much of the annoyance from the source alluded to, even if the soilage were still allowed to run to waste; and the same processes would allow of the discharge of the soil drainage of a town into a watercourse whose current might not be swift enough, nor, it may be, in sufficient quantity to carry on the suspended matters, or rather, to prevent them from depositing in the immediate locality out of which the soilage may have arisen, and from which it may be desired to remove it.

The demand so commonly made upon watercourses, even if they are no bigger than brooks, for power to work mills, makes most of our smaller watercourses very bad recipients for the soilage of adjacent towns, and there are

very many towns in England which have no better means of relief than the dammed up waters of such watercourses afford. Hence the taking up and removal of soilage to serve the purposes of manure is much to be desired as a sanitary as well as an economical measure.

It is obviously essential to the effectual relief of a town by drainage, that no building in or out of which matters requiring to be carried off by drains can arise, be built at so low a level, with reference to the eventual removal from the town of such matters, that the perfect drainage of the building cannot be effected by existing and available means of discharge.

The inhabitants of many large districts in London suffer grievously because their houses have been built at so low a level, or so far down in the ground with reference to existing sewers, or to any possible sewers of which the contents can flow away, that the lowest floor cannot be drained. It happens in many towns, indeed, that whatever sewers may exist have not been made deep enough to drain existing houses, the sewers having been intended for surface drainage alone,—the soilage going to cesspools. Such is the case with regard to Paris, which is, in the proper sense of the term, thus a wholly unsewered town ; but it seems to be peculiar to London that people are heavily taxed to build what pretend to be sewers, of which they can make no use. Large and costly works

of the kind have been executed in Lambeth, and at a high level with reference to the surface of the ground, because of the general lowness of the surface throughout the district, with reference to the means of discharging the soilage. Buildings have been built, nevertheless, and they continue to be built, and streets to be formed, at such low levels that the sewers are of no use to the buildings as soil drainages. Surely the authority which appoints commissions with power to levy money upon the inhabitants, present or future, of any district, ought to impose upon the commissioners the duty of making the sewers deep enough to relieve the buildings of the district of their soilage, though it had to be all lifted for the discharge; or otherwise to prohibit the erection of buildings with any floor at a level so low that it cannot be drained by sewers having a natural discharge.

No system of drainage can be carried out in any town with full effect unless provision be made by authority to the effect that when existing buildings cannot be otherwise fully relieved, artificial means shall be employed to relieve sewers of their contents; and that no building be erected in any locality for the purposes of occupation in such manner that soilage will arise within them, of which any floor shall be at a level so low that it cannot be effectually drained by existing and available means of relief.

It is further requisite to the effectual drainage of a town that there be such a supply of water to buildings intended to be occupied for the purposes of life, that all matters entering their drains may be attended or be followed by water enough to carry the soilage onward without depositing any of its substance within the drains, and that there be also such a supply of water to the main drains or sewers, either in a constant flow or in frequent and copious flushes, as would prevent the soilage from being arrested within them length of time enough either to deposit filth or to evolve noxious gases.

The fall of drains and sewers ought to be greater, and may be less, according to the provision available for scouring them, or of keeping up a current within them in any case. Half an inch of fall in every ten feet is the slightest fall that any house-drain ought to be laid to under the best circumstances; that is to say, when the supply of water to the house is so ample that the consequent waste or consumption will certainly furnish a good scour therefrom; but one, two, or even three inches of fall in every ten feet in length of such a drain may be requisite when the waste is likely to be slack.

A fall of one and a half inches in every 100 feet in length is fall enough for a main drain or

common sewer when it has a well-formed and evenly built concave bottom, and when a constant flow of water, in quantity sufficient to prevent the soilage from depositing any of its heavier matters in the sewer, may be relied upon; but the fall should be greater when mere flushes of water are to be used as a means of carrying the soilage, and still greater if the filthy fluids received from house-drains are to be penned up within the sewer, wherewith to flush it. As it regards size, house-drains and town-drains,—or private drains and common sewers, to use the terms more commonly applied to them,—seldom require to be of the large sizes of which they are usually made, for the mere reception and passage along them of the soilage of the building, or of the town or district; but there are sufficient reasons why they should be made larger respectively than would be sufficient for that purpose alone.

All soilage drains should be made watertight, that the liquid parts of the soilage may not escape into the subsoil and leave the solid matters in the drain; and in using drains of small size, as soil drains to dwellings, care must be taken to protect them from the access of any substance capable of resisting the available current of water. With care in this respect there are very few ordinary dwelling-houses in towns of which the soil and

water drainage will not find ample room to pass along in a tube equal in capacity to a cylinder of six inches in diameter.

To protect buildings from the foul air generated in, or returning by, their own drains, the waste-ways should be double trapped—by a bell-trap at the sink where waste water enters from the surface, and by a well-trap, or what workmen term, in plainer language, a stink-trap, short of the inlet to the drain; and the communication between the waste-way and the drain should have such a fall, or be so much above the bottom of the drain, that the overflow may be always from the well into the drain, and not from the drain into the well. If, however, bell-traps might be soldered down, and it were done, well-traps in addition would be unnecessary. (See Appendix II.)

The supply of water to a town for the ordinary purposes of life is hardly within the scope of the present work, but the supply of water for the purpose of perfecting the main drainage of a town is proper to be considered in connexion with the regulation of buildings, as incidental to the wholesomeness of the town. It may be suggested in this place, therefore, in what manner a proper supply, to the effect and for the purposes herein contemplated, may be made available in almost any town; and taken in connexion with the

plan recently established, as already referred to, of turning to account as manure the soilage of towns in its fluid state, water with which to flush and scour the main drains or sewers may perhaps be supplied in most cases at no great expense; even if the plan itself should not prove to be as profitable as its promoters have thought it likely to be.

Few towns, in England at least, are so happily situated with regard to supplies of water as to possess sweet and perennial streams from such elevations as to be able to obtain it within the buildings at high levels, or indeed to obtain it within the buildings at all, without the application of artificial power, and by the aid of costly services; and consequently there are but few towns in which water can be spared wherewith to flush and scour the sewers of the town from the sources which yield water fit for the ordinary uses of life. Every town, however, that is seated upon or near to a river or by the sea, has at its command the means of flushing and scouring its main drains or sewers with water, and of watering and cleansing the surfaces of the streets, at a comparatively trifling cost, though the water may not be fit for domestic consumption.

An artificial lake, or an extension of the present ponds in the Regent's Park, London,

might be constituted a reservoir, and be supplied with water by any of the present Companies who take water out of the Thames, and whose main-pipes go up or near to that park, at a very trifling cost to the public, and add greatly to the beauty of the locality, whilst waste-pipes might be led from such a lake to the upper ends of almost all the main sewers which lie between Bayswater brook and the course of the Fleet, and between the park itself and the river; and as such waste-pipes need not be of large bore for the purpose required, the expense would not be worth consideration in comparison with the good that might be thereby effected. The water sent up for such purposes need not, of course, be filtered water; but Thames water—especially when taken out above the bridges—is as pure as any merely ornamental water need to be, whilst it would scour the sewers as well as if it had been filtered. It may be remarked, too, that any such reservoir as above suggested might be used—as the Serpentine in Hyde Park is used—by the public as a safe and easily accessible swimming bath.

It may be remarked here, in illustration of what has been said in the text, that since Bayswater brook has become a much-used sewer, and so that it would bring soilage instead of water to the pond or lake called the Serpentine River, in

Hyde Park, the Serpentine has been fed by one of the western Water-Companies, with water from the Thames; and further, that a large proportion of the water required for the navigation of the Regent's Canal, from Paddington to Limehouse, is supplied in like manner with water thrown up to it from the Thames. The Regent's Canal might thus, indeed, be itself made to serve as a reservoir for water available to flush and scour all the sewers of London, of which the upper ends are below its level in any part of its course.

What may be done for the western parts of London by means of a reservoir in the Regent's Park may be done for the parts northward by a reservoir on Hampstead Heath, and so on, indeed, throughout the whole town on both sides of the Thames; and what may be done in London may be done at any other town;—towns by the sea-side having the advantage of cheaper fuel, though they may not have water-works so situated as to be able to raise sea-water for scouring the sewers of the town as well as to supply the town with sweet and potable water, and find it necessary, therefore, to erect works.

But if works be established for taking up the soilage brought down by the sewers of towns, to return it to the uplands as manure, the same power and machinery, the same stand-pipes, and, to some extent, the same mains, will do the duty

and serve the purpose of raising water to upland reservoirs, with which to flush and scour the sewers; and with this advantage, too, that inasmuch as it has been found that the soilage of towns as brought down by the sewers is commonly too strong to serve the purpose of manure without dilution, and requiring, therefore, to have water added to it, the addition of water may be made by turning it on from the reservoirs in the quantities required, so that the fluid may come down thoroughly mixed, of the proper strength, and fit to be returned as manure, without being first tanked for the purpose of dilution.

If it were practicable in any case to ensure a constant and copious stream of cold water through the drains of every building occupied for the purposes of life, and through every sewer of the town, the sewers discharging themselves into the sea, or otherwise in such manner that the soilage should be at once, upon its discharge, dissipated or removed from the site, it might be unnecessary in such case to take any measures for the ventilation of drains and sewers. But whenever the means are not present and assuredly available of constantly and perfectly scouring away and removing the soilage of a town, the consequences of making house-drains the imme-

diate recipients of matters which heat compels to throw off foul and noxious odours—accompanied or followed by hot water which may have been employed for culinary purposes or for washing, and thus be itself very far from pure—are, that the drain of every building occupied for the purposes of life is almost always charged with noxious, expansible, and insinuating gases. These the common endeavour is to keep down by all the means available to that effect, but they are seldom kept down with such effect that their presence is not from time to time patent to sense; the endeavour of the gases to escape being aided by the ignorance of domestics and of those who do household work for themselves, who tear up or otherwise derange the traps which are put at the inlets for waste to keep the stench down,—by frequent defects in the machinery of water-closets and in the drains themselves,—and by the demand which domestic fires make for air when doors and windows are all closely shut. But if the foul gases are prevented from escaping upwards, the drain must stand full of them, overflowing or pouring out—whichever may be the better term to express what neither expresses correctly—into the sewer what the house-drain itself will not hold; and hence it is that steam may be so often seen, and stench so constantly felt in the squares, streets, and alleys

of London, rising out of the sewers through the gully-gratings and other vents, to nauseate the inhabitants when they go out of doors and to poison the air about their habitations before it enters them.

This great evil cannot perhaps be wholly cured without such constant charges of cold water to the drains as would keep them at so low a temperature that gases will not be thrown off from the substances liable to evolve them, under circumstances which favour their evolution.

It is a fact well known to all persons who are conversant with the subject, that the temperature in those of the sewers of London, into which many house-drains fall, is at all times much higher than in the open air;—generally, indeed, from 30 to 50 per cent. higher.

But the evil may be so greatly alleviated, nevertheless, that, taken in connexion with proper trapping of the inlets to its drains and proper supply of air to the fires, no house need be exposed to any foul smell from its own drains, and if the plan to be described were applied in all houses and other inhabited buildings, very little noisome smell could, under ordinary circumstances, rise from the main drains into the streets. The plan is, to form a flue like a common chimney-flue in or against one of the walls of every

building as a ventilating flue to the drain. The light and expansible gases formed in house-drains under the action of heat would rise in such flue according to their natural tendency, and vent being given to the foul air, its place would be supplied by air from the main drains or sewers into which, by the gully-gratings, the denser outer air would enter, reversing the current, indeed, and establishing a circulation which would remove the foul air of the drains to the upper air above the tops of the chimneys, to be dissipated by the wind. It would, perhaps, be proper to make the drain-flue distinct from the chimney-flues where it opens out above, so long as the defective ventilation of buildings in other respects renders the chimney-flue of an apartment the only means of access to it of the outer air when the doors and windows are all shut, or the foul air brought up by the drain-flue may be caught up by the down-draught of its neighbour chimney-flue. The hovelling of the drain-flue would go far, however, to prevent any such consequence as that last alluded to, whilst the application to any such flue of a tube or cowl of almost any kind will check down-draught, or, better still, aid the rise and escape of the gases from the drain below, if it be properly devised to that effect. Drain-flues will, of course,

require to be airtight from the insertion of the flue into the drain to its opening out into the upper air above the roof of the building, and may be built in brickwork or may be formed in pot-pipe, or of metal, as may be most convenient; but to any new building such flue may, as before remarked, be built in or in connexion with any—the most convenient—wall of the building, as if for a chimney-flue; and it may in such case be used advantageously for carrying off the products of the combustion of gas used for the building, or of any fuel which will not emit smoke liable to deposit soot in the flue.

But the ventilation of house-drains, or of the drains from any other buildings, may not, perhaps, be alone sufficient to prevent the evolution and the escape by the gully-gratings of foul gases in the main drains or common sewers when the sewers receive large quantities of hot water from such establishments as breweries, and receive, in addition, perhaps, to the soilage of houses, animal and other matters from slaughter-houses, and from manufactories employing such like substances, liable, like the refuse of dwelling-houses, to be acted upon by heat to the same effect. Under such circumstances—and these are circumstances presenting themselves in a greater or less degree in all towns—provision should be made for

ventilating the sewers, in the parts at least where such circumstances may operate. Ventilating shafts to the sewers, arranged to the same effect as flues to house-drains, will give the foul exhalations which now escape by the gully-gratings vent into the upper air, where, as before remarked, they are dissipated by the winds of heaven and rendered harmless in new combinations. It may be further desirable in such case — that is to say, when greater heat in the sewers prevents the counter-current which the heat in the house-drains would otherwise establish between the gully-gratings and the drain-flues—to flap the inlets from the gullies to the sewers, or what are called the gully-shoots; but in such case air must be allowed to enter the sewers freely at their lowest level, that is to say, at or near their outfalls, that the means of circulation through all the drains and up all the ventilating flues may be secured. There is no danger that any of the foul gases evolved in the higher parts of a sewer will be emitted by low shafts at the lower ends, if the means of escape are provided for them above. Smoke does not commonly descend when it is free to rise, nor will the rapid gases from house-drains go down or be poured into the sewers if they are allowed vent into the upper air; nor, again, if they are formed

in the sewer, will they travel down to the outfall if they can find a way up by the gully-holes, or—if a more legitimate way is provided for them—by ventilating flues and shafts.*

It is a good general rule in all matters relating to constructions, that every part of any work liable, in its use, to derangement from any cause, be made accessible for the purposes of repair or of renewal. This rule ought to be carefully adhered to in all matters relating to the drainage

* The author having recently considered the subject of the drainage and ventilation of towns, in connection with supplies of water for the purpose of scouring the sewers and cleaning the streets of a town, in a joint Report; after an authorized inquiry by Mr. Rawlinson of Graythwaite and himself, upon the provisions of Bills before Parliament for the improvement of that highly improveable but wholly unimproved town, Sunderland, he has appended to this book the substance of that Report so far as it is of general application. (See Appendix III.) The Report upon the Sunderland Improvement Bills was made in February last, but in a professional Report to the Commissioners of the town of Leamington, made in October, 1846, the author finds that he intimated further as to the ventilation of drains and sewers, that the same system “may be carried to the greatest degree of perfection, by the application of some mechanical agency to draw the foul air out at the upper shafts. Pumps worked by windvanes or by any more constant power, would effect this object, and so would fires in close furnaces fed with air drawn by the fire down the lower shafts, and through the sewers to the upper shafts, up which the foul air would be carried with the rarefied products of combustion in the furnace.”

of buildings ; whether it be of water, as liable to affect the structure, or of soil, as liable to affect the health and comfort of the inhabitants of any building.

But, in providing for easy access to whatever pipes and drains may occur inside a building, the arrangements to secure that object should be made in such manner as to occasion the smallest possible amount of inconvenience within the building whenever occasion may arise for employing them. And in like manner, as it regards the connexion of private or house drains with the main drains or sewers,—and as to the building and the repair of the sewers themselves, indeed,—arrangements should be devised to such effect that all such works may be executed without interfering, or with the smallest possible amount of interference, with any public way, or with the convenience of the public in the use of the public ways.

The practical necessity that exists of attending to the cited general rule makes it difficult to employ pipes fitting with spigot and faucet joints in the soil drainage of buildings, because they cannot be easily opened in any place ; but this difficulty would be removed in some degree, and smaller pipes than prudence will otherwise permit would be allowable as drains, if arrangements

were made at the head, and short of the outfall, of every house-drain, for access to it in such manner as to allow of the use of an articulated apparatus, similar to that employed in sweeping chimneys, to clear away casual obstructions—the most frequent cause of derangement to the soil-drains of dwelling-houses. On the other hand, common sewers under all roads which are considerable thoroughfares ought to be built large enough for workmen to pass into them to clear obstructions and to effect repairs; with access from above-ground at bye-places provided for the purpose in laying out the scheme, so that the roads and streets be not at any time unnecessarily deranged for any such purposes.

THE VENTILATION OF BUILDINGS.

It may appear paradoxical, but it is certainly true, nevertheless, and the foregoing observations may be referred to for the reasons that it is so, that the introduction of soil-drainage to the buildings of a town renders greater space about buildings essential to the healthfulness of the inhabited locality than the old system of deposit as to excreta, and of surface-drainage as to

water, required. Towns will be found to have been almost always built upon sites of which the immediate subsoil is percolable by liquids, and into which the excreta arising in and from human habitations have been dejected by means of privies over cesspools formed in it; and, as before remarked, no volatile and active gases are thrown out, under such circumstances, in quantities sufficient to produce any sensibly injurious effect upon the atmosphere. The foulness of old towns which stand upon dry sand or gravel, or other percolable stratum of soil, may be referred rather to accumulations in and about the buildings of such corruptible animal and vegetable refuse as may not be thrown into the cesspool, and which cannot be made to pass away by drains: so that, in truth, effective scavengering is the first essential to wholesome ventilation, when excreta are dejected upon a soil which will absorb the liquids, as it is, indeed, with whatever system of sewer soil-drainage may be applied. It is not to be overlooked, nevertheless, that such soils as allow the liquid parts of excreta to pass away, do but filter them down into the water, which is apt to re-appear in the wells, and so, under some circumstances, to poison one of the supports of life in another direction. But however disgusting this

idea may be upon reflection, it does not always occur to the mind ; and it is not until the close crowding together of human beings into the small space which the original site of an old town comprises, that any effect really injurious to health can arise from that source ; nor is it, indeed, to the source referred to that the most disgusting apprehension is traced, but to the deposit of the mortal remains of humanity within the strata from which springs of water are derived. Nor has the necessity of drainage, as a means of relieving towns of soilage, and of the consequent exhalations evolved upon exposure to heat and air, become recognised, because of the defects of the system which retained the solids of human excreta within or immediately about the buildings in a town situated upon a bed of dry gravel, but because towns have outgrown their sites, and extended their buildings to the clay which so commonly occurs under beds of sand or of gravel. London has in this manner outgrown the limits of the gravel bed, and has been thrown upon the blue clay underlying the fine stratum of gravel which forms the banks and bed of the Thames in its course through London, and which comes to the surface at from one to two miles inland on each side of the river. No sooner was the clay touched by buildings, than the necessity

of soil-drainage became apparent; and in the endeavour to secure such drainage in places where it is absolutely essential to allow of the occupation of the site for human habitation at all, a system deficient in a most important particular has been carried out, to the serious detriment of those parts and places which are closely built over, and the air of which will be more injured by the exhalations of the steaming soil-drain, than by anything emitted from a close cesspool dry-steined in gravel.

To repeat. Perfect scavengering is the first essential to cleanliness, and to the protection of the air from pollution in and about buildings, the excreta arising in which are dejected into dry sand or gravel; whilst the soil-drainage of buildings will not supersede the necessity of scavengering, nor, having regard to the wholesomeness of the locality, ought it to be preferred to the dry cesspool, where a dry cesspool is available to the effect already indicated, unless provision be first made for scouring the contents away, and for removing directly to the upper air the gases which they will evolve in their passage.*

* In coal countries, where ash and cinder arise in large quantities in even the poorest dwellings, and go to the ash-pit or dust-bin with animal and vegetable refuse, &c., the injury to the air of the locality from defective scavengering is not so great as in London, and other towns where coal is dear.

Doors and windows ought not be taken into consideration in connection with the ventilation of buildings; they are provided for facility of ingress and egress to and within the building, and for admitting light to the several apartments, and cannot be applied to promote ventilation in the seasons, and under the circumstances, which make ventilation most highly desirable. It is not enough, indeed, to set a window or a door open to admit fresh air into an otherwise un-ventilated apartment, even when windows and doors can be properly set open. The air must be drawn in, or it must be pressed in, and in either case there must be a way of escape for that which the apartment had previously contained; and as two opposite currents of the same kind of fluid can hardly pass one another in the same orifice, the ventilation of an apartment—that is, the establishment of a current of air through it—can only be properly effected by the establishment of opposite currents through different orifices. In this manner it will be found that a fire-place, with an open flue from it leading to the outer air, will act in concert with an open window, by allowing an up-draught to be fed by the window, or by permitting a down-draught, according to the state of the

atmosphere and the direction of any currents of wind, or as there may or may not be a fire in the chimney, or heat affecting its flue from fire in another chimney. But the state of the atmosphere is uncertain, currents of wind are unsteady and changeable, and, moreover, open windows are seldom consistent with fires as sources of warmth, and the common domestic focal fire may not, therefore, be relied upon as a means of ventilating an apartment in connection with open windows. Moreover, one-third of the life of civilized man is passed in apartments within buildings, under circumstances which, for the most part, preclude open windows, and render fires either inconvenient or unnecessary as a source of warmth. One-third of the lives of three-fourths of the people of England is passed, however, in rooms which have no chimney at all, or of which the chimney opening has a board before it, and of which the doors and windows are all shut as closely as the occupiers can shut them. In the cases of the few who may indulge in bed-room fires in the winter, or of those who will open a bed-chamber window an inch or two in the summer, the former allow the fire to divide with them the pent-up air of the apartment, and the latter shut down the register-flap,

or put up the chimney-board, to prevent the circulation, which the state of the atmosphere or of the wind might bring about.

But although, between the focal fire which compels air to enter, and the chinks and crannies by which, when doors and windows are shut, the air is compelled to pass, some amount of ventilation is obtained in the customary day-rooms, it is mainly through the lower parts of a room, and to the height of the chimney-opening, that any change is really effected; and even this amount of ventilation is not obtained without exposing the occupiers of the room to cold draughts; whilst in summer time, when the air of an apartment is sought to be changed by opposite open windows, the occupiers are exposed to draughts which are often as much more dangerous, as they are more agreeable, than the cold draughts which the fire compels in the winter.

Fire-places and their flues, and doors and windows, may, therefore, be fully provided in any building, and to every apartment of a building, and the building and its apartments remain wholly unventilated in the proper sense of the term, which—it may be repeated in another form—consists in the continued flow into the building, and into its apartments, of fresh air, in a state to be agreeable as it regards temperature,

and in a manner which shall not constitute a sensible current, and the consequent ejection from the building of spent or otherwise deteriorated air, and this at all times and seasons. But air is an inert body, and will not move either into or out of an apartment, unless something be done to induce movement; but it yields ready obedience to any action that does not seek to compress it, and responds freely to any endeavour to draw it. It will neither enter a close room, unless way is first made for it by the exit of what may be there already; nor will it submit, without resistance, to be pressed into a close room, but it will follow in at one opening if air be drawn out at another, or it will enter and drive out what might be already in possession of the enclosed space with the slightest possible force; that is to say, the way out being as large as the way by which the air is pressed in.

Some power must, therefore, be employed and applied to secure the movement of air, necessary, in the first place, to the ventilation of a building or of an apartment, and irrespective of the condition of the air as to temperature; and the power employed should be certain and constant. But there is no power placed at our disposal that can be relied upon as certain and constant, without involving labour, that is to

say, expense; whilst the purpose under consideration is one, of which people generally do not see the necessity so clearly, nor feel so acutely, as to induce them to be at charges to promote it.

People, who would revolt at the idea of drinking out of the same cup or glass with a stranger, or even with a guest, suffer no annoyance from, and feel no disgust at, inhaling what has already passed through the lungs of those who may be shut up in a room with them, however close the room may be, and whether the room be an apartment of a dwelling-house, a shop, a chapel, a church, or a theatre. In respect of the ventilation of buildings used as habitations and otherwise, for the purpose of social intercourse, amusement, and duty, civilization is in a state analogous to that of the New Hollander, who, having put an old hat on his head, or a skirtless coat on his otherwise uncovered body, is clothed to excess for all the purposes of comfort, whilst any idea involving a question of decency is wholly a stranger to his mind. Another phase of foulness as it regards ventilation is found in the practice of the tobacco-smoker, whom fastidiousness would prevent from taking up a cigar that had been between the lips of another; but who seems to be unconscious that, although the expired air of untainted breath may rise as it passes the lips, the air comes dense, and tainted with a nauseous odour, out

of his mouth, and, refusing to rise, is perforce inhaled by whoever may follow the same way ; the squeamishness being exercised in his own favour, and the grossness to the loathing of his neighbours.

But although power, involving expense in its establishment, maintenance, and application, is necessary to effect the proper and complete ventilation of any buildings used for the purposes of habitation in civilized life, a much greater approach to ventilation than is generally attained may be made without the additional expense which the employment of a certain and constant power would impose, if advantage were taken of the agencies which nature provides without charge, and of those which are commonly established and maintained for other purposes. The agencies provided by nature, available towards the ventilation of buildings, consist in the difference in density of the atmosphere at different temperatures, and in the force of the wind : the one always, to some extent, available, as between the inside and the outside of a building ; and the other only available when it is in force, at which time, however, it is liable to act with more than the desired effect, if the means of its application be adapted to render its services of use when it acts but slightly. These agencies being taken

together, however, and aided rather than checked, as they would be according to the common practice, by the heat from the flues of the fires which are to be found in every dwelling-house, at least, to a greater or less extent, all the year round, will be found to do much if properly applied to ventilation in most ordinary cases.

Let every fire-place be connected with the outer air by a flue, tube, or other means of communication in the wall, or through or under the floor, opening out at the lowest level above ground and admitting the air behind the range or stove, or rather behind the faces or cheeks which may be made to form a coffer about the fire-box or grate, shut off at the top by a metal plate, or by the boiler if it be a range, or by tiles set to that effect; and make openings through the faces or cheeks at the level of the hearth to let in air before the fire, and so that the fire may be fed with air which it will compel to enter, and be spared the task of checking the desired up-draught in whatever flue or flues may be provided to carry off the foul or spent air from the apartment, or from the inside of the house generally. If the air so delivered by the special provision made for every fire, is in sufficient quantity—that is to say, if the way for it be large enough, and it ought for the purpose to be equal in area in its transverse

section to the register-way over the fire—there will be no draughts in the room when the doors and windows are shut, although the wind may force currents if the joints be badly made; and, moreover, the air admitted to feed the fire will take up warmth enough from the grate, in passing behind and about it, not to be disagreeable if it escape into the room and be felt, nor detrimental to the purposes of a fire used for cooking.

The fires being thus provided with air for the purposes, as well as with vents for the products, of combustion, will make no demand for air upon those vents—that is to say, upon their own smoke-flues, but, on the contrary, send a stronger draught up them. In such case the chimney-flue may be made the means of removing the spent air from the room itself by an opening made under the ceiling into the flue. But, it may be said, there will be an effective up-draught only when there is a fire burning in the grate—and that is true, and therein the operation is defective for the full purposes of ventilation; and, it may be added, that it does not yet appear in what manner the room itself is to be supplied with the air which, when spent, will be drawn into the flue by the up-draught, occasioned by the combustion going on in the grate when there is a fire. And to supply the deficiency in this

respect without resorting to the clumsy, dirty, and uncomfortable practice of letting cold air in behind and under the skirtings of a room, the current of sweet air coming in by a flue or tube, and delivering itself behind and about the grate, may be made to do the double duty of feeding the fire and supplying the room for the purposes of respiration.

It has been said that the inlet for fresh air to the fire should be equal in area to the area of the register opening, and a register is almost essential, over the fire ; but a supply by such an inlet will be in excess of the demand of combustion in the grate, inasmuch as the register opening must be always large enough to carry off the smoke, or steam rather, which coal, when it first reaches the fire, throws off ; and although this should be followed by a full body of air, much of what the fire would draw in will pass up the flue unconsumed, when the simple purposes of combustion alone have to be supplied. The register-flap will admit, therefore, of being partially closed during the long intervals between the coalings of a fire, and the fresh and tempered air emerging from the openings through the cheeks of the grate will enter the room to supply the place of what the chimney-flue is drawing off by the orifice under the ceiling. By this simple process, and

with most inexpensive mechanical arrangements, every room in which a fire is employed may be pleasantly and most wholesomely fed with air, and be, to a great extent, really and effectually ventilated so long as a fire is employed. And, indeed, the arrangement indicated for feeding the fire and ventilating the apartment when fire is employed, is not wholly inoperative for the purposes of ventilation when no fire is burning; for if the register-flap be shut close, so that air may not pass into the flue over the grate—that is to say, at a uselessly low level in the apartment,—there will be for the most part an up-current, by the flue leading out into the upper air, induced partly by the heat of the flue itself and partly by the greater levity of the air in the upper part of the room, the feed of fresh air being still by the inlet behind and through the cheeks of the grate.

So long as the up-draught is certain, that is, as long as a fire is burning in the grate below, and the fire is well supplied with air, there will be no danger of anything coming down the flue. But inasmuch as the flue is a smoke-flue, and soot is liable to be deposited in it, and flues are commonly so built and so finished at the top that the wind, in making Pan's-pipes of the pots, may dislodge soot in the flue, and overcoming the

slight up-draught, drive it through the orifice into the apartment, it is necessary to apply some simple self-acting valve which shall close the orifice to the slightest pressure from the side toward the flue, and open it to an equally slight pressure on the side of the apartment. Such a valve has been devised by that excellent physician—applying the term in its proper as well as in its conventional sense—Dr. Arnott; and although a dingy hole, however disposed to the effect intended by any mechanical arrangement of the kind last alluded to, is not a sightly spot in the side of a room, it will be accepted, by all who can appreciate its effect, with the old adage, “Handsome is that handsome does;” though, again, there is no necessity that in building anew the effect should not be provided for and obtained without any unsightliness whatsoever. But wherever the windows whereby the light of heaven is admitted to houses and other such buildings are mere holes in the outside walls, openings into flues for the discharge of spent air may surely be excused if they do not succeed in being, under all circumstances, handsomer than the windows.

Rooms which have no chimneys in them, and the passages and the staircase voids of buildings, may be ventilated to some extent by means of mere air-flues formed in the walls and opening

out over the tops of the buildings, if these be responded to, freely, by open windows or by proper inlets from the lower levels, so that there may be no inducement to the outer air to pass down the flues; and this effect is the more especially to be avoided if there be other flues discharging near to their outlets spent or otherwise foul air, which it is not desirable to have drawn down into the building. To secure in some degree and at some times, at least, a certain up-draught in such ventilating flues, tubes may be applied to the outlets of the flues above, upon which the wind shall act to that effect; and any tube that has been found to aid the draught of a chimney will almost certainly do something to promote it in a mere air-flue, and so secure, as far as may be without *certain* power, the desired current into and out of the building with which it is connected. But—to prevent the possibility of misapprehension upon this point—let it be well and clearly understood that any success in promoting up-draught, with the effect of removing foul air from the inside of a house, will be most assuredly followed by down-draught in the chimney-flues, and consequently smoky chimneys if there be fires, and soot if there be none, unless ample provision have been made for in-draught of air below, to feed any fires and to supply the

place of what the up-draught may take away. There is a tendency, a slight tendency, which any access of heat will quicken to an up-draught in every flue leading from a lower to a higher level, and this tendency is stronger in proportion to the height of the flue; so that to give otherwise unventilated rooms, being high up in any building, the advantage of this tendency, the inlet for air should open out at the lowest attainable level above ground, always avoiding any sunk or confined area in which there may be matters, even temporarily deposited, which can injure the quality of the air—as, in ventilating a church, fresh air should not be sought among the depositories of the dead. And this tendency to up-draught may, it has been said, be further aided by mechanical appliances to the outlet above; but it must not be forgotten that the air admitted into a room to supply the place of what is carried off by any up-draught is supposed to be wholly untempered, and during the summer season no tempering is necessary, perhaps even at night; nor, indeed, is it really so at any season of the year in England, if the inlet to the room be so disposed, with reference to the uses of the room, that the current through from the inlet for fresh air to the outlet for spent air be properly directed, and if there is no fire to induce an insensible current to become

an annoying draught. People who appreciate fresh air do not hesitate to adopt appliances for admitting it, though in an untempered state, and it will be found that of the infinite varieties of ventilation which late years have presented to meet the growing demand—such as louvered glass in a frame, capable of being wholly or partially opened and shut,—a zinc pane perforated so as to modify the force of the current of air through it, directly, and by inversion made to act indirectly—none are capable of taking up air at the best point, or of delivering it where the current may be least inconvenient, as air-flues are, when properly disposed to that effect in or in connexion with the walls and floors, that is to say, at the higher levels in any room.

But if buildings, or rooms in buildings, occupied by the poor and ignorant,—for it is not the poor alone who are ignorant, nor, indeed, are the poor always so—or in other terms, by people who do not feel how filthy foul air is, and who do not therefore heed the foulness of the air of unventilated apartments; if such buildings are to be ventilated, it must be by processes which act independently, and which cannot operate offensively, as by cold draughts; and such processes must be, moreover, inexpensive, to give them any chance of being largely adopted. Opposite air-flues, or

flues opening to the same apartment in opposite walls, the flue on one side giving vent to the spent air at the highest level the room affords, and that on the other side delivering fresh air at the same high level, will go far to fulfil the conditions stated, even where there is no fire, and more perfectly so where there is a fire whose place is arranged and whose combustion is fed with air in the manner before described, when the process will, by the pleasantness of its results, ensure its own immunity from ignorant interference, while it requires no manipulation that a child may not supply.

But again, as to aids to up-draughts as a means of ventilating buildings. The combustion of gas in lighting may be rendered available to this effect, when and where the focal fire, or, its equivalent, fire in any stove of which the products of combustion are led to a flue, is not in action, by leading the products of the combustion of the gas to flues, instead of allowing them to be thrown off inside the building. But here, again, air must be supplied to support the combustion of the gas, or the gas will compel down-draught in any flue with which it may be connected, or, in the absence of such connexion, it will do as it commonly does, aid those to whom it gives light to destroy the pent-up air of the apartment in which it may be used, to the detriment of the

light perhaps, but to the injury of those with whom it co-operates in destroying the air.

When economical circumstances will admit of the application of certain and constant power to the purposes of ventilation, it may be concluded that the means of tempering the air will not be wanting, so that the process of ventilation may be rendered complete as it regards any buildings in and to which all the requisite appliances are available, without recourse to make-shift expedients and without consenting to imperfect results. It might be thought unnecessary too, in a work like the present, to deal with the subject as it presents itself under such circumstances, further perhaps than to repeat the remark, that the same principles are applicable in all cases; but in repeating the remark it is impossible to blink the fact that it is not enough to do so, for the principles are not generally understood by those who are commonly charged with the direction and execution of the operations which are intended or desired, and sometimes, perhaps, expected to result in the ventilation of the building acted upon.

The most prevalent notion seems to be, that the ventilation of a building consists in making the air that happens to be in it hot, and in leaving holes in some part or other of the building through which any surplus heat may escape from it

Official duty imposes upon the author the necessity of inspecting almost all buildings erected for public purposes within the Metropolitan District—that is to say, churches, chapels, lecture-rooms, concert-rooms, and the like—with reference to the sufficiency of the structure of the building; and it is seldom that an instance has presented itself of the recognition of the most obvious principles of ventilation in the buildings which have thus fallen within his observation in the course of the last three years. Sometimes inlets for air, besides the doors and windows, are to be met with, and more frequently openings in luffered turrets and through the ceilings are provided, to let spent air out, it may be supposed; whilst here and there air-flues occur; and most expensive apparatus for making hot the air to be admitted are not unfrequently found, but it is rare indeed to find an instance of both inlet for fresh air, whether tempered or not, and a way of escape for spent air, both in the same building; whilst the application of power either to establish and maintain up-draught, or to force tempered air into the building, is hardly to be found at all. But it is not alone such public buildings in which attempts at ventilation are made in a manner wholly devoid of all useful purpose. In club-houses and in public offices, in banking-houses and in taverns, the luffered glass ventilator may be seen in the windows, producing in summer no useful effect in which a partially opened window will not excel it, whilst in winter it is screwed up tightly, that it may

not admit a cold draught. Sometimes in private houses, and in other buildings too, sly ways for the escape of spent air are made in the curbs of skylights, or by an ingenious disposition of the glass to that effect; but the potent fires demand air, and a cold down-draught points out that the skylight or lantern-light, or something about it, is defective. Sometimes, again, an opening may be found to have been cut into a chimney-flue to take advantage of the up-draught of the fire, but here again no way has been provided for air to feed the fire, and the valve is close shut; or the fire, like the inmates, would seek to respire again the air it had already destroyed. The very absurdity, indeed, of providing for the exit from an apartment of spent air without providing for the admission of air in some condition or other to supply its place, cannot perhaps be more aptly illustrated than by supposing a barrel of beer to be tapped, and no vent made; whilst dependance upon the opening of a door or window to give the requisite 'vent' to an apartment, may be likened to giving vent to the barrel by drawing the bung every time a jug of beer is wanted.

Power may be applied in the ventilation of buildings, either—as already remarked—by forcing in the fresh air, or by drawing out the spent air, and a light and simple pump of not more than a turnspit power will suffice to ventilate almost any building of average size, to the extent

of establishing an equable and sufficient current of air through it; so that, whether the pump be worked by direct or by reversed pumping action, there be both an inlet and an outlet fully equal to the capacity of the pump, the outlet at least being not liable to be acted upon by any currents of wind. Thus, if there be an apparatus for warming air, it should be placed at a low level, in free communication with the outer air, which should be warmed in its way into the building, and the warmed air passing freely into the building, a pump applied to a lift-case, or other tube or flue opening to the interior at a high level diagonally opposite to the inlet, and worked there, the whole of the air in the building, so far as it is exposed to the current, may be changed in a time that can be calculated, the fresh warm air taking the place of what is removed—that is, if all the other inlets besides that for the warmed air be closed, and the warming apparatus and its means of warming be sufficient; and in like manner, in the season when it is not necessary to warm the air before it is admitted, the same action will change the air and cause substitution of fresh for foul, though the ways in may be greatly increased by opened windows and doors. Conversely, the power may be applied at the inlet for the warmed air, when the

reversed action of the pump will throw air in ; there being, as a matter of course, a way out provided ; when the spent air, meeting with no sensible resistance, will pass off by such outlet, and so thorough ventilation will be effected.

A very beautiful example of the latter mode of ventilating a building with carefully tempered air, has been applied, under the direction of Dr. Arnott, and is in operation at the Hospital for the Cure of Consumption and Diseases of the Chest, in the Fulham Road, London ; and the same process is in course of application, under the same direction, to the barracks for the Royal Marines at Woolwich.

The quality and temperature can be better secured when air is thrown in than when it is drawn in, inasmuch as the sources of supply can hardly be assured when the air may answer to the action of the pump by accidentally opened doors, imperfectly shut windows, or other ways, as well as by that specially provided. Air may thus be drawn in from a foul quarter, as in the case of a church surrounded by a burying-ground, or having a charnel-house under it ; but this latter mode of applying power may, nevertheless, be the easier and cheaper way, and it will generally be so whenever the means of warming and of distributing heat by means of pipes, or such

like matters, have already been provided, as such means will generally admit of easy adaptation to the former mode.

It is not necessary to point out in this place in what manner, or from what source, power may be most economically obtained for the purposes of ventilation in any case, nor indeed would it be easy to make any suggestion upon that point that could be of general application.* A very small amount of power is enough for the proper purposes of ventilation in any building, however large it may be, if the same current can be conveniently made to act throughout it, as in a church or a chapel; whilst in the case of a theatre with its recessed boxes and galleries, and the necessary connection of the audience part with the stage, and the parts about that compartment of such a building, the effective ventilation requires a more complex process, and it may, therefore, require a comparatively much larger amount of power.

But having referred to the subject, it may not be out of place to remark that many churches

* It seems to be hardly necessary to say that in all manufactories in which steam or other power is required and employed for driving machinery, or otherwise, there can be no question about means of working all requisite apparatus for ventilating the building.

are supplied with a certain and constant power, so placed for the most part, with reference to the body of the church, as not only to offer itself, but to offer itself in the most convenient place for the purpose of promoting the effective ventilation of the building whenever its services may be required. Church clocks have, or ought to have, power beyond their ordinary work, to overcome the effect of the highest wind upon the hands, so that every church clock may be supposed able to spare power enough to work, at sufficient speed, the light pumps necessary in any case to draw off the spent air from the body of the church. And the church clock is placed in the tower, and the tower rises so much above the body of the church, that it may be most easily made to act as the ventilating flue to the church. Thus, in winter-time the withdrawal of the cold air by pumps in the tower, fitted into flue-like lift-cases and geared to the clock, will give the warming apparatus, which ought perhaps to be diagonally opposite, or thereabouts, to the outlet into the tower, the means of warming the church in a much shorter time than when it has to act upon the confined and inert body of cold air which the church may have contained; inasmuch as the pumps would, in withdrawing the cold air, compel the fresh air, tempered by the warming apparatus, to supply its

place ; and this operation being effected before the services commence, the church would not be felt by the assembling congregation to be either cold or close, and the ventilating process continuing, the spent air would be removed as it arose, and its place being supplied by fresh and tempered air for respiration, the faintness and weariness which so often distress a congregation in a close unventilated church would never be felt : nor would the operation be less beneficial in summer-time, when the horizontal flaps to the half-hopper windows of churches stand, without such operations, unavailingly open, as the cooler outer air cannot rise to flow over the hoppers, even if it could make its way in against the pent-up air already enclosed. But the pumps in the clock-tower, worked by the clock, summer as well as winter, and drawing the spent and heated air out from under the roof or ceiling of the church, would compel the outer air to supply its place within the church, by whatever ways it may be found in any case most to the comfort of the congregation to open for its admission.

The meagreness of our experience of easy and familiar means must be taken to account in some degree for the vagueness and uncertainty which may be thought to pervade the foregoing remarks upon the ventilation of build-

ings, whilst that want of confirmed experience might perhaps have justified the omission of the subject in a work which professes to be a guide. But with the belief that a certain amount of real information has been attained, and in such form as to be capable of being applied in practice, it seemed better to state it than to refuse to deal with the subject because the practice may not be fully established. Many of the remarks in the foregoing pages will appear trite to those who have already given their attention to such matters, but daily experience proves that the principles which they are intended to embody are not generally understood, and moreover all that is known will have to be repeated, and much that is uncertain must be tried over and over again, before the proper ventilation of buildings shall have become a practical science.

It may be added, nevertheless, that the simpler processes hereinbefore set forth, as available in ordinary dwelling-houses, are the results of the author's own experience and observation. He has succeeded in supplying rooms with pleasantly tempered fresh air, and in drawing off the spent air by the agency of the fire in a common parlour grate, by the arrangements described in the preceding pages as sufficient to produce those effects. An outlay of a few pounds in the first instance has been much more than saved in fuel to the fire and in doctor's bills, and far more than compensated by the sense of comfort and wholesomeness

which the process induces. He has obtained, in like manner, experience of the beneficial effect of mere air-flues, ranging through height enough to make the slight difference in temperature produce an up-draught ; and he has found the advantage of a simple mechanical contrivance applied to a common zinc tube in drawing off the spent air which rises by the well-hole of the stairs, and which is commonly diffused in the uppermost bed-rooms of a house. What has been done, in the manner and to the effect indicated, is to a house of the most ordinary kind, after it had been built and long in use, and, as intimated, by comparatively inexpensive arrangements ; and the same may certainly be done with much better effect in building anew, and as well in the poor man's cottage as in the mansion of the wealthy.

INCONVENIENCES ARISING FROM PROJECTED BUILDINGS AND PROJECTIONS FROM BUILDINGS.

THE inconveniences arising from projected buildings, and from projections from or before buildings, towards, upon, or over the public way, as well as those which arise from the uses of buildings tending to the injury and discomfort of the neighbourhood, might be considered rather matter of police regulation than of regulation as it regards buildings; but to whatever jurisdiction the prevention of inconveniences from such causes be referred, it is the building, or parts of a building, which require to be regulated, whether it be to avoid or to prevent inconvenience; and therefore the subject may be properly dealt with here. And in dealing with it, it may be necessary, in the first place, to refer to an objection which is always uppermost with those who attach more importance to what are thought to be private rights than to the common good, the objection being that no man ought to be restrained from making what use he may please of his property, so that, in using, he do no injury to his neighbour; and

that the neighbour, being protected by the law of the land, upon the maxim involved, requires no special protection. But the kind of use contemplated under this head as tending to occasion general inconvenience and discomfort, and in its effect to check and otherwise interfere with the due circulation of the air, is one in which near neighbours in towns are very generally agreed among themselves; and consequently the common neighbour, the public, who has no individual existence—what is everybody's business being nobody's business, even if "everybody's" case were properly secured against anybody's encroachments upon the light and air, and the convenient and comfortable use of the public way—is exposed to such great disadvantages as to render special protection of the public interests necessary. Moreover, near neighbours are not always agreed to do the same thing at the same time, or in the same manner, or to the same extent; and as the owners, or other the occupiers, of neighbouring property are so easily affected injuriously by one another in the disposition each of his own property, as it regards buildings and projections from buildings, and as the public in towns is so much at the mercy of individual proprietors within the town in respect of such matters, it seems to be as necessary to provide specially for

the protection of individual owners and occupiers against one another, and of the general public against every individual member, in the disposition and placing of buildings and parts of buildings, with regard to one another and to the public way, for the avoidance of constantly present annoyance, inconvenience, and discomfort, as to provide similar protection against merely possible contingencies of incendial fire, or to provide for the protection of the public from buildings in danger of falling.

The practice set forth in the Introduction as prevailing in the extension, or other the increment of modern towns—of which the suburbs, formed in the first instance by the extension of the principal lines of streets upon the roads leading into and out of the town, have the houses and other buildings erected fronting to the roads, but set back to some distance from them, whereby the established general lines of the front lie well back from the public way—is not, however, a universal practice in modern towns, nor was it ever the practice in many of the older towns; and as to some very large towns, every variety of practice in that respect may be found in their various borders. But if advantage be claimed for the public because of established general lines lying well back from a spacious road, it must be necessary that

the public should consent to accept the result of an inferior practice, and to adopt general lines formed by the fronts of existing buildings crowded up to a narrow road. It seems clear that general lines resulting from one kind of practice may bear hardly upon the owners of building-land lying adjacent to the roads, without yielding corresponding advantage to the public; whilst those resulting from the other kind of practice would lead to the worst effects as it regards the public health and comfort. And as it regards individual and neighbouring owners, desirous of turning their lands fronting to the same road to account for the purposes of building, no general line being prescribed to them, or to either of them, by anything by which they ought or are required to be regulated, one of them may think it better to set back any buildings he may erect to a relatively long distance from the road, and the other to build close up, or at any rate closer, to the road; and there being no general line, and the operation of building being simultaneous, neither can be called upon to adopt the line of the other, and the public would suffer from the vagaries of both. And, again, when one may have built either up to, or far removed back from, the road, to which the lands of several owners on the same side may front in common, the second

builder should be restrained from doing what his neighbour may have done already to the disadvantage of the public, whilst he should be protected against an unreasonable sacrifice, and an inconvenient disposition of his buildings, because of anything that the adjoining or neighbouring owner may have done for his own convenience, or to gratify his own whim.

It would appear, therefore, that general regulation of the original disposition of buildings, with reference to the public ways, is necessary alike for the protection of the public and of adjoining owners; but any regulation ought to be administered with discretion, and not by the Procrustean law,—width of way and the setting back of buildings from the public way in and about towns being matters to which no unyielding rule can possibly be applied without a sacrifice of the public good in some cases, and of private rights for no public benefit in others. The fact of a general line having been established, should not be conclusive against either the public interest or the private right; nor should private owners be allowed to establish building lines that may be detrimental to either the public or the owners of adjacent or of neighbouring lands.

To a very large extent full effect is given to proper regulation in the disposition of buildings

with reference to streets and roads upon the extension or other increment of towns in England, and particularly as it regards London, by the circumstance that the great bulk of the land is held in large quantities by the same owner, and the owners being for the most part persons in easy circumstances, if not, indeed, of large fortune, lands are laid out for building with a liberal consideration of what the circumstances of the locality do or may require ; and buildings being erected upon such lands upon leases, are subject to whatever regulations of the kind in question the owners choose to impose. No doubt the owners have regard to their own interests in properly disposing their lands for building ; for in this, as in most other matters of social import, individuals who do wisely for themselves do well for the public. But there is still a large extent of land in and about most of our principal towns, as there certainly is in and about London, held in small quantities, and by owners who can have no control over one another, and who are hardly controlled in any way by any existing law in the disposition of their land for building, however they may be controlled in the erection of the buildings ; and there are large properties held by owners, either as individuals or as corporations, who are needy, careless, ignorant, or misjudging,

or whose affairs are conducted by incompetent or otherwise improper persons, all of which require the operation of some general regulation, alike for the protection of the public and of neighbouring owners. No regulations, and no administration of any general regulations, need to require or to do more for the public than they do of themselves who do wisely for themselves; and, consequently, these would feel no restraint, but would rather receive protection from any measure tending to compel the wayward and to protect the feeble.

The necessity of some effective regulation, as it regards buildings and blocks of buildings breaking the general line, will be made to appear by the following illustrative instances, some affecting the public, some private owners among one another, and some affecting both the public and the neighbouring owners :—

No sooner had that enormity Langham Place Church, in London, been built, so as to make a narrow strait between the convenient width of Regent Street and the wide sea of Portland Place, than the owner of a piece of unoccupied ground a few yards further on, and on the same side, at the commencement of Portland Place, built a row of houses advanced before the line of the fronts in Portland Place, nar-

rowing the ample but not inconveniently wide foot pavement in that part, obstructing the pleasant view towards and over the Regent's Park and the uplands of Hampstead, and helping the church to impede the circulation of the air and thereby to lessen one of the contemplated advantages of Regent Street. It is possible that Langham Place Church was brought forward advisedly, however unadvised the project, to occupy a central point in the termination of Regent Street, but the advance of a mean-looking block of houses before the general line of the houses in Portland Place seems to have had no other purpose than the destruction of that uniformity of style which gives the houses in Portland Place a certain kind of interest, and the injury of the public, who had just paid for Regent Street, and had thereby improved the value of the ground so applied. Under proper general regulation, effectively administered, the public authorities would not probably have formed the gorge in the road, and certainly the further wrong would not have been done to the public by the protrusion of the piece of plasterer's architecture beyond it.

In a comparatively rural part of the Metropolitan District some houses had been built fronting to a road, and at distances back, or in, from the road of 50 or 60 feet. At a little way from these, and on the same side, one man chose to build at about 100 feet back, and the next to him not desiring to put his house so far back, began to build at

70 feet in from the road. The man at 100 feet back complained that his view along the road was injured by the house at 70 feet back, and the 70-foot man retorted that his view over the country was intercepted by the house 100 feet back. But the general neighbour—the public—is injured by the unsightliness of the existing arrangement, as much at least as the next neighbours are injured by one another, whilst all that the only authority the State had appointed, with reference to such matters, could say, was, that the general line of fronts, so far as it was established, was at the 50 or 60 foot distance, and that the 70-foot house was not before the line as it regarded the 100-foot house, whilst no provision appeared to exist to protect the 70-foot man, who had built last, against the obstruction to his view over the country by the 100-foot house.

In another part of the Metropolitan District, and also in a rural part, six or eight houses had been built in a row about 20 feet in from the road; and at some time after, the next neighbour but one, as to ownership of land, built a shorter row of houses at about 25 feet back from the road. When this had been done, the intermediate owner built a row of houses between the two, at from 10 to 12 feet in from the road. But the owner who had built the short row 25 feet back in one place, had also built a house at the further extremity of his land, and fronting another way, but the flank of which was towards the road in question, and the corner of it nearest to the first-mentioned

short row is but 11 feet in from the side of the road to which these front.

Here no general line could be laid down after the facts, without injury to some or other of the neighbouring owners, whilst any line imposed on the part of the public before the facts would have protected them all from the injury they have inflicted upon one another and upon the public.

Surely it is desirable that there should be some competent authority established to protect the public from the crowding and discomfort which such unarranged proceedings occasion, and to protect individuals from the consequences of their own independence. But people are very indignant, nevertheless, if anything is assumed for the public at the expense of what they deem their rights, though they are always ready to claim protection from the public against the waywardness of a neighbour who has only exercised the same freedom of action which they claim for themselves.

Regulations for the protection of the public from ignorance, inability, cupidity, or caprice on the part of the owners of building lands, or of those to whom they may intrust their lands for building purposes, as it regards the original laying out for building, and the building upon lands with reference to the ways either originally be-

longing to, or made for the use and convenience of the public in the use of such buildings, and in passing to and from the parts beyond, should embrace also the conservation of existing general lines ; or so to guard the public and the neighbouring owner, that any departure therefrom be not to the detriment of the public way or of the neighbourhood, whilst the owners of property should, nevertheless, be able to make such use of it as they may desire to make, consistently with the general good.

The public rights are perhaps the strongest, as they are certainly the most marked, in ancient lines of road into and out of towns, but it is upon these that the encroachments of the private owners of lands first show themselves. The field next the road has been fenced off from the road or from the footpath by the road-side, by a hedge, or by both hedge and ditch, and the public have used their road and path time out of mind, with elbow-room enough, and both have been open to the rays of the sun and to the winds of heaven. The right of the owner of the adjacent land is supposed to extend to the outer margin of the ditch, or to the toe of the bank on which the hedge grows, and when the land is to be taken up for building or for any other purpose which may render a close fence desirable, and although

the owner may have never had any profitable use of the soil beyond the inside toe of the hedge-bank, the hedge is grubbed up, the ditch filled in, and a close paled fence, or it may be a brick or stone wall, is set up at the road-side edge of the ditch, or at the outer toe of the hedge-bank, whichever may be towards the road. Thus the way is effectually narrowed, and the sun and the wind, and the view over the country beyond the fence, are all shut out;—the rights of the owner in such cases always outriding the rights of the public. This process is going on day by day about London, and probably about all our towns; but it ought not to be so, and to conserve the ancient ways, and the inalienable public right of light and air, any fence of any kind substituted for hedge and ditch, or hedge alone, should be set in from the edge of the ditch or toe of the hedge-bank, whichever may have been the margin of the public way while light and air played through the quickset or holly hedge upon the pleasant path, to a distance equal, at least, to the intended height of the fence above the level of the road or path.

The fence or the line of fence between any land and an ancient public road being so established, all buildings to be erected fronting to such road should be set back from the boundary-

fence to a distance equal in like manner to the height of any such intended buildings above the level of the footway nearest to the site, whilst any question of greater distance would be a question between owner and owner on the same side, determinable by the public authority upon submission by either or by any of such owners.

After that stage, and until dwelling-houses are required to be turned into shops, the public would seem to have no further question with the private owner, but when this latter stage is reached, whether the road be an ancient public way, or one formed out of the heretofore private property of the owner, but made the channel of public intercourse for the advantage of the ground and buildings which it intersects, and to which it may give access, the public interest requires that projections made from or before any building, shall be made in such manner, or to such effect only, that light and air to the public way, or to the buildings fronting to it, shall not be diminished, nor the convenience of the public way lessened, but that the probably increased traffic upon the road and path be provided for out of the ground before the buildings, and that any advance of the buildings towards the road be without detriment to adjoining or even to neighbouring owners.

It is most certain that if matters of the kind in question were under such regulation, that reasonable projections, though they formed additions to the original buildings, might be made before buildings towards the public way upon condition that an equivalent addition were made to the road and path, and both the public interest and the private owner be benefited. It is alike barbarous to prohibit everything and to permit everything, but the one condition or the other prevails in most places at the present time in the matter now under consideration ; and the effect of a wholly prohibitive regulation in a matter which the public interest does not require to be wholly prohibited, is that the regulation falls wholly into desuetude, or that it operates partially and therefore unjustly. London affords a striking illustration of this statement. The making of projections before buildings has been prohibited by statute, and by statute after statute for nearly two centuries, but projections of the kind, and in the manner and under the circumstances set forth in the prohibitive rules, are made every day in, and on almost all sides of, the town:—not in every part, certainly, because of the greater conscientiousness of the district surveyor in some cases, and because of public spirit on the part of the parochial authorities, who insist upon

having effect given to the law, in others ; but the result of giving effect to the law in some parts and leaving it to be a dead letter in other parts, is to show more clearly that the one extreme is as unnecessary to the public good as the other is opposed to it. If the Metropolitan Buildings Act—the statute which now deals with such matters in and throughout London—had permitted projections to be made before buildings upon conditions and with limitations, instead of prohibiting them in equivocal terms and under uncertain conditions, much of the mischief which has continued to operate since the repeal of its effete predecessor would have been prevented, and much actual injustice have been avoided.

No rule, as before remarked, can be of general application in such matters, unless, indeed, it be one wholly prohibitory, which ought not to be, unless, again, there be confided to a proper authority power of relaxation in certain cases. The parochial and other local authorities consenting,—the landowners, who may be affected, not objecting,—and the owners and occupiers of the buildings being willing,—it ought to be competent to the parties interested to make other use of their buildings than that for which they were originally intended, and to render them fitter for such use by bringing them practically nearer to

the public way lying before them, so that the public be compensated by such additional width being given to the road and path as the circumstances of the case may require, and so that the projected parts be made in other respects wholly unobjectionable.

The foregoing remarks have reference mainly to the suburban roads, and the same general proposition ought, perhaps, to apply to roads upon which the buildings are similarly disposed, though in the heart of a town. The cases occurring in the streets which really compose the town, may probably be dealt with by more nearly determinate rules.

The conventional and economical necessity of obtaining from the smallest site within a town the largest amount of accommodation, has led very generally in England, and almost universally in London, to the formation of one story of every ordinary-sized dwelling-house below the street-level; and the necessity of providing access of light and air to this story has led to the provision before every such house of a void open space, which is of greater or less width, in practice, according to the locality and to the style or pretensions of the buildings. This open space, being sunk, requires to be securely enclosed, and the

enclosure is made at the street-level; and when the building is built as and for a dwelling-house, the enclosure is commonly an upright iron palisaded railing. In this manner streets obtain greater width in respect of light and air than is given to the public way, and thus a really narrow street, as it regards the ground actually passed over by the public, may be ample for the uses of the occupiers of the houses fronting to it, and for the ordinary intercourse of life through and about it, as it is free from the obstructions with which trade encumbers the ways to and about the buildings in which it is carried on. Trade, however, makes its way into any such street, and brings with it greater concourse of persons, together with the obstructions which attend greater intercourse in the business of life; but, coming gradually, the effect is not immediately apparent, though the lapse of a few years will exhibit the once quiet and comparatively spacious street crowded and uncomfortable: the area railings will have been thrown down, the heretofore open areas covered with bulky projections at the level of the street, and, standing up to the street, encumbering and obstructing the footway with outriggers which overhang the way and further impede the circulation of the air. Conditions imposed by ground landlords may, and do in

some cases, prevent this course from being taken, and the area may be to some extent retained unenclosed, except as to a shop-front, and the iron palisades may be turned down to cover the area and form an open hurdle for people to walk over. But the public interests are not properly provided for even when this latter course is taken, whilst in the former case the lowermost or basement story of the houses are rendered pestilential dens, though still containing the domestic offices, and the new shop itself is commonly but little better for the same want of air, though it may retain some share of light, and the public are huddled together upon a practically narrowed road ;—and, in the latter case, if an addition be really made to the public footway, it is by means which render it rude and dangerous.

So long as trade is carried on in any house or houses built and externally disposed as dwelling-houses, no sensible effect is found, in practice, to be produced upon the public way, and no rules need to be made applicable to such buildings that do not apply to them as dwelling-houses, having regard to the public way ; but when a shop-front is put into the front of any house towards a street, and goods are exposed to attract the attention of passers-by, and to induce more persons to come the same way, or to that side of the way, greater

width of way has become necessary to put the public in the same position, as to convenience, that it enjoyed before the shop-front was put in. The conversion of a series of ordinary dwelling-houses into shops ought, therefore, in all ordinary cases, to lead to the widening of both the carriage-way and the footway of the street in which such conversion is made; but if circumstances seem to make it unnecessary to widen, or there be not space enough to admit of the widening of, both, the footway or ways should have the advantage. The difference between the demand upon the footway by private dwelling-houses and by shops making a display as such, can hardly be reckoned at less than one person more moving, and one standing upon, or otherwise occupying space in traversing, the footway; and the provision to be made out of the space between the houses, when converted into shops, and the street, ought to be not less than two feet for each person. Four feet, therefore, and as much more as may be conceded, being added to the footway, ought to be wholly and solidly paved over, and at the inner margin an effective fender-rail, not less than eighteen or twenty inches high, should separate any void, whether open or grated, between the shop-front and the widened footway from the footway; but no part of the shop-front should overhang such

fender-rail so as to drip upon the pavement, but a projection, structurally of incombustible materials, might be allowed to extend from the front wall of the house so far towards the inner margin of the widened pavement, that, terminating as a shop-front, the glass of the front should be eighteen or twenty inches within the fender-rail or palisade, and so that the whole bulk do not exceed once and a half the thickness of the wall from which it may project, and so, moreover, that a good general line be maintained.

So consistent with the purposes of a shop-front is the arrangement which would result from the above-stated project for a rule, that it is very frequently to be met with in the better parts of London, having been adopted not only without compulsion, but often under the disadvantage of being exceptional.

When the projection forming or terminating in a shop-front is in its structure of wood, other reasons will interpose to require a narrower limit than the above-stated rule would give; whilst the width of the street and the height of the buildings fronting to it might be such as to require that no projection of any kind be made beyond that of window-sills, string-courses, and copings, whatever the materials may be.

Taking projections generally, and of what nature soever, from or before the fronts of build-

ings towards the street or other the public way, none should be allowed to overhang the public way, whether the mere inconvenience arising from it alone be considered, or if this be considered in connection with the obstruction to general light and air. All matters assuming the guise of architectural decoration upon or about the wall or walls of a building, ought to be considered as parts of the wall upon or about which they are placed or applied, and the extent of their greatest projection ought to be taken to be the face of the wall. Not, indeed, but that to the fronts of buildings not used as shops the concession claimed for, and conceded to, shops might be reasonably allowed to the extent in the height of a shop-front, that is to say, to the height of the story of the building in which it occurs.

Thus the Geological Museum, now erecting near St. James's Church in Piccadilly, and the addition to the Carlton Club recently erected in Pall-Mall, might be properly allowed to throw out projections in their ground-floor or effective basement stories, respectively, before the general line of the fronts of the houses on the same side of the street, in each case to the extent, and to the extent only, to which shop-fronts might be allowed in such situations and under such circumstances; whilst the columns and entablatures above, being properly parts of the walls of the buildings, ought not to

project before the fronts of the houses or other buildings between, or among, which the buildings referred to stand.

Shallow, or comparatively shallow, horizontal projections, as cornices and balcony floors, need not perhaps be limited to the general line of the fronts, but they ought not under any circumstances to overhang the public way, nor ought they to be allowed, indeed, of unlimited projection. Twice the thickness of the wall under it would be a reasonable limit for the projection of a balcony floor placed not higher in the front of a building than the level of the floor of the story next above that nearest to the street level, and once and a half the thickness of the wall if at a higher level; and three-fourths the thickness of the wall under it, of a crowning cornice being of the same or of similar structure to the wall; whilst the cornice resulting from an overhanging roof may be allowed a greater projection, when no detriment to the light and air, and no danger in respect, or in the event, of fire, is likely to be occasioned or increased thereby.

Dead walls and close porches ought not to be allowed before the general line of fronts: that is to say, as to the former, that any such walls as division walls of several occupations ought not to be more than shoulder high at the utmost; and

as to the latter, they might, perhaps, be allowed the range of shop-fronts so far as regards height and projection.

Open porticoes before private buildings ought to be strictly confined to the space not given up to the public, and the circumstances are very few indeed which can justify the projection of a portico from even a public building over the footway of a street; although continuous arcades and colonnades so placed may be found under some circumstances consistent with private advantage and not inconsistent with public convenience.

The question of projections *behind* buildings, or on the sides of buildings not towards streets or other public ways, is one in which the public has a large interest, because of the choking up of sites, and the injurious effect produced thereby upon the general circulation of the air in a town; but it is altogether too large a question to be entered into here, though there seems to be no reason why an authority proper to regulate for the public and between neighbouring owners as to matters projecting from the sides of buildings towards public ways might not be empowered to act for the public and between the parties as to matters of the same kind affecting or liable to affect neighbouring owners or the neighbourhood, though not affecting the public way.

POSTSCRIPT.

THE REPORT OF THE SANITARY COMMISSION, AND THE CHOLERA.

THE First Report of the Metropolitan Sanitary Commission having appeared while the preceding pages were in the press, the author is induced to add a few remarks, mainly by way of suggestion, with reference to the most immediate object of its solicitude—the apprehended re-appearance of Cholera in London.

The Report most truly states (p. 48), that in general little or no improvement has taken place in the sanitary condition of the back streets, lanes, courts, and alleys of the Metropolis, since the prevalence of cholera in 1832, and the Commissioners express thereupon their “fear in regard
“to this disease, that complete measures of prevention must be eventual on the combination
“of works, which must be the subject of further
“investigations; but in respect to the immediate
“and special measures available for its preven-

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“tion, they find that such would be measures of
“cleansing of whole lines of sewers, from their
“commencement through the several districts to
“the outfalls; the cleansing of cesspools (where-
“soever it may be effected into the sewers), and
“the removal of whatsoever may be removed in
“suspension in water, in the various modes of
“flushing by the use of additional and abundant
“supplies of water.”

Now what is here set forth as proper to be done, is undoubtedly highly desirable to be effected, *but to do it with an epidemic raging, and with a plague marching upon us with steady pace in the midst of a mild and damp winter, would be, to say the least, most hazardous*; while the benefit to be derived from it will probably not avail in any degree the “back streets, lanes, courts, and alleys,” where, to apply the language of the Report, “people live irregularly, or on unsuitable diet, and at the same time filthily,” and consequently, it may be added, “in the habitual respiration of an impure atmosphere.”

But the effect of disturbing the deposits in sewers is also clearly indicated in the Report: “If, in an upper district, a part of the line of
“sewers is flushed, to keep it free from deposit,
“the effect upon the lower district, in which the
“flush exhausts itself, is to disengage more co-

“piously the offensive emanations. . . . When
“the sewers in the Holborn and Finsbury divi-
“sion have been clean flushed, it is stated that
“the inhabitants of that district, even up to the
“New River head, have been annoyed by the
“currents of offensive gases up the sewers, from
“the accumulations in the lower districts, where
“the same cleansing operations have not been
“carried on” (p. 23). The conclusion here stated
is, it may be remarked, in some degree assumed
against a fairer presumption that the emanations
arise, mostly, in the part submitted to the opera-
tion of flushing, and through the process itself as
hitherto practised; inasmuch as the liquid em-
ployed for the purpose, in the district referred to,
is more commonly the heated and sweltering
soil drainage itself of the district, than water.
This liquid having been penned up, to form a
head by which to make it act with effect upon
the sedimentary matter upon which it is to be
turned, will, when set in motion as a flush or
scour, account for the foulest emanations, with-
out referring to the deposits throughout either of
the cities of London and Westminster.

With reference still to the proposed immediate
disturbance of the deposits in drains and cess-
pools, the Report states (p. 22), upon the autho-
rity of Mr. Bowie, that at the time, it is to be

understood, of the last appearance of cholera in this country, “ under the influence of great alarm, “ cesspools were emptied, drains and sewers “ opened and cleaned out ; and the contents of “ the drains and sewers, if not of the cesspools “ likewise, were accumulated in the streets, and “ left in small heaps for the convenience of carriage ;” and that “ this matter was highly “ offensive when first placed on the surface, and “ produced in some cases an intolerable stench, “ so that I thought the very means taken to “ lessen the disease, tended to increase the evil.”

And what happened then will happen now, if the same thing be attempted to be done again in a hurry, for however skilfully the operations may be conducted, it will be found practically impossible to avoid leaving heaps of the disturbed foul matters open to the air, for some time, and in some places ; and the greater the force employed, the greater, in some respects, the danger to be dreaded, because of the enormous surface collectively of the filth beds, which will be for days, weeks, and months throwing off poisonous exhalations.

But the Report itself indicates moreover where the immediate danger lies, and that it is not in the quiet deposits, but in the exhalations from the active matters in the drains and sewers. After a series of striking illustrations to the same

effect, the Report cites (p. 6), "the most striking
"illustration on record, of the influence of ill-
"contrived sewerage on the origination of cholera,
"supposing the epidemic once prevailing. One
"morning it was discovered that several men on
"board a vessel, lying in one of the Docks at
"Liverpool, had been seized with cholera during
"the preceding night. The men were sent to
"hospitals, and the vessel having been imme-
"diately warped into the river, another ship with
"a healthy crew took up her station. The next
"morning all the hands on board were ill of
"cholera; and on examining the Dock it was
"found that a large sewer discharged its contents
"under the spot where the vessel was placed:"
the clerk to the Commissioners of Sewers for
Surrey and Kent stated (p. 39), as a reason
why house-drains, in connexion with the sewers,
were not numerous, that he believed it to arise
from the effluvia of the sewers, and that he knew,
as a fact, that a communication by drain from a
house to a sewer has really made the houses more
disagreeable to live in, or more unhealthy: and Mr.
Phillips, the surveyor of the Westminster district,
stated (p. 29), that in going along the sewers he
almost invariably found the flare of the light,
which he held in his hand, to be carried into the
mouths of the house-drains; so that there must

have been, Mr. Phillips says, direct currents from the sewers through the house-drains, and so into and through the houses themselves.

Now it is not intended for a moment to say that the system of soil-drainage proposed for the Metropolis, as foreshadowed in the Report in question, is not capable of producing the best results; but looking at the great extent of the Metropolitan district, and the present condition of the district, in respect of drainage, and the enormous mass of foul matter accumulated in many of the works intended for drains, and in cesspools, it will be found, as before remarked, practically impossible to effect any real good by immediate operations upon the deposits in the present sewers, in the short time that can elapse before the plague will be upon us; *while it may be gravely questioned whether any attempt to check or prevent disease, by disturbing the deposits, will not, indeed, both engender and foster the plague.* It were well if it were done, but the danger lies in the doing. Moreover, the removal of filth *from* the sewers and drains must be made *to* some place; and where is the place to which it can be removed,—even if the process of removal be left out of the question,—without carrying pestilence with it? If it be loosened in the

drains and sewers, and scoured with water into the Thames, the quantity is so great that the Thames itself will be poisoned, and the whole atmosphere of London will be injured therefrom to a greater degree, most probably, than it is injured by the undisturbed deposits; and if the filth be carted away, the question still remains,—Whither? It is far from improbable that the exposure to the air of the filthy sweepings of the streets and of the contents of the middensteads of Sunderland in a huge, accumulated mass in one place, did more to induce cholera in that town in 1831 than all the other causes of disease together.*

There is, however, a mode of operation indicated in the Report itself, which is easy of application,—of which the means are to a large extent present,—which cannot by possibility do harm, and which would probably not only remove all present danger from the foul state of the existing sewers, but go far to enable the more radical operation recommended in the Report, to be carried out innocuously. It seems certain, from the above-cited statements of the Report itself, that the emanations from the sewers, while the deposits in them remain undisturbed, are foul and noxious, and that to these, when directed in force upon

* See Appendix III. p. 284.

any inhabited place, the worst consequences are attributable; and, moreover, that this poison is, by existing arrangements, thrown back into our habitations through the channels provided for discharging the matter out of which they arise. Mr. Faraday's letter, at page 39, of the Report, suggests a practical course for withdrawing the poisonous exhalations from all the sewers which can be brought into communication with any of the many furnace-chimneys in operation throughout the Metropolitan district, and these will be found most frequently in those parts of London where their services are most required. Arrangements may, doubtlessly, be easily made with the owners of such works, for leave to make the requisite connexions; and where no furnace chimneys can be made available, temporary shafts may be soon run up to give effect to the operation, whilst every householder whose house is drained into any common sewer may, at no great expense, aid such an operation and protect himself, by connecting the drain of his house with some existing flue in one of the walls of the building, and if it be with a flue through which a fire acts the better; or by having a metal tube set up against the back wall of his house, opening into the drain below, and into the open air above the roof of, the building.

It is hardly necessary to remark upon the hasty observations in the Report tending to depreciate Mr. Faraday's suggestion, nor to show how much less dangerous light and expansible gases must be when delivered at eighty or a hundred feet over our heads, to the action of the winds, by which they are led to form new combinations, and so to become fitted in the course of nature for new duties, than they are whilst roaming under our feet, seeking and finding vent into the air about us, and which alone we can breathe.

The importance of removing foul air from drains and sewers does not appear, indeed, to have fully impressed the authors of the Report. Remove the causes of foul air, it may be said, and there will be no foul air to be removed; but it is in the very removal that the foul air arises, and unless the cause of its evolution can be put a stop to, means must be adopted for the removal of the exhalations inoffensively and innocuously, as well as for the removal of the coarse matters which are themselves nocuous only because of the foul air which they throw off. But heat is the cause of the evolution of foul air, and unless the Commissioners are prepared with a project for cooling down the scullery waste before it enters the drain in every house, foul air will still be generated in the drains and in the sewers, and as foul air cannot

be dissipated by flushes of water, it will still rise at every gully-grating, of which the shoot is not flapped, and in every house having a drain into a sewer, of which the bell-traps are not soldered down, and will pour itself out at the outfalls, wherever they may be. What can be clearer, moreover, than that the effect remarked by Mr. Phillips, as to the up-draught from the sewers through house-drains, is induced by the domestic fires which draw upon the drains for air, all other access for it being, as hereinbefore remarked, carefully precluded; and that, consequently, houses are ventilated by the way of the sewers through the agency of the drains! Smoky chimneys would probably follow in many cases upon the soldering down of the bell-traps or otherwise stopping the way for air from the drains to the houses; but the remedy is easy. Supply the fires with air from a purer source, and make the fires, if you please, help to carry off the foul air from the drain with the products of combustion, but do not compel it to find exit into the air under your windows, nor compel it to poison the air and induce pestilential diseases at the river side.

The Report would, however, have all sewers and all house-drains made of no greater capacity than enough for the passage of the liquid matters which it may be desired to discharge by them;

and, therefore, it may be supposed, foul air will find no room to lodge in such drains and sewers, and the matters will, moreover, by additional supplies of water in flushes, be hurried along them too rapidly to allow of the evolution of foul air in the drains. Without stopping here to remark further upon this point than that sufficient consideration does not appear to have been given to the liability of house-drains under ordinary circumstances to receive matters which may choke pipes of three inches in diameter, and to the impossibility of establishing the extraordinary circumstances which shall render house-drains free from that liability, nor to the enormous amount of inconvenience that would arise from the necessity of opening from above down to every sewer under all the streets in London, upon every occasion requiring access to it, when the sewers are of such small sizes that men cannot enter them,—it may be enough, with reference to the present exigency, to say, that almost all existing house-drains, and a large proportion of the sewers, are so large that there is room in them for foul air, and that foul air is generated in and discharged from them in vast quantities; and further, that deposits of filth will be found to exist in drains and sewers not so much with reference to their sizes, respectively, nor altogether to their form in transverse section,

but to the insufficiency of their fall, and to the absence of back-water to carry the soilage on, and so to prevent it from depositing in the drains.

The most eligible course for adoption under present circumstances seems to be—firstly, to apply the means indicated of drawing out of them, and discharging into the upper air, the air generated in the drains and sewers, that it may no longer require vent in the streets or at the outfalls: secondly, to sluice or scour the sewers with water to the largest possible extent, but not otherwise to disturb the deposits in them until the impending danger be past; and—simultaneously—to remove all surface soil and filth, and reduce the contents of all cesspools—though it must not be hoped to get rid of much of the soil from the cesspools by any existing sewers, nor is it indeed to be desired unless it can be certainly hurried on through the sewers, and in a diluted state, to an effective outfall.

The Commissioners do not state throughout how large a proportion of those districts of the Metropolis which purport to be sewered, the sewers are of no use to the houses as soil drainages; that is to say, of which the sewers can be used only for surface and water drainage. They question the Clerk of Sewers for Surrey and Kent as to the proportion of

house-drains which have been joined on to their sewers, and as to the miserable result of connecting houses with miserably devised sewers; and they make sport of poor Mr. Gwilt, and his Encyclopædia, but they omitted to elicit from him, or they omit to mention it in their Report if they did so, that, for the most part, the sewers, upon the building of which Mr. Gwilt has been employed for the last forty years, are so placed with regard to the houses, that the soil drainage of the houses cannot be received into them; that, indeed, as before stated in the body of this book, builders have been allowed still to build houses at such low levels that they cannot be drained into the sewers, and that the Commissioners have gone on building sewers into which the houses could not be drained. It will be found, in all probability, that there is nothing in many of the sewers in Lambeth and in other similarly situated parts of London to be scoured out, and that water would therefore be thrown away upon them, whilst there will be thousands of houses whose inhabitants have paid sewer-rates ever since they were built, having cesspools brimming with filth, which the sewers are not adapted to carry away.

Nor do the Commissioners expose the full extent of the imbecility exhibited in the practice of some of the District Commissions. The writer of these pages had occasion some six or seven years ago to inquire for the means of relieving a building at the East end of London, and found that the nearest sewer was

1. The first part of the paper is devoted to a general discussion of the problem of the existence of a solution of the system of equations (1) for a given set of initial conditions. It is shown that the system of equations (1) has a unique solution for a given set of initial conditions if the functions $f_i(x, y, z, t)$ are continuous and satisfy the Lipschitz condition with respect to the variables x, y, z .

APPENDIX.—I.

(See page 184.)

RATES FOR THE BUILDINGS AND CONTENTS OF WAREHOUSES IN LONDON,

Occupied by Wholesale Dealers in Cotton, Linen, Silk, Woollen, and Worsted Piece-Goods, and by Wholesale Glovers, Haberdashers, Hosiers, Lacemen, and Thread Manufacturers; regulated by the Capacity or Cubical Contents of the Buildings.

	Not exceeding 100,000 Cubic Feet.	Exceeding 100,000 but not exceeding 200,000 Cubic Feet.	Above 200,000 Cubic Feet.
A WAREHOUSE,			
Brick-built and Tiled or Slated.	not less than	not less than	not less than
Having entire party-walls carried through the roof			
Having no window or opening into an area, court, or passage, between and common to it and any other warehouse			
Having no wooden lining to any part of the ceilings or walls			
Having no well-hole for hoisting or lighting; nor other opening in the floors, except for the staircases and teagle rope	2s.	3s.	3s.
In single tenure only			
Having no process of manufacture carried on therein			
Having no stove with more than 3 feet of pipe . }			
ADDITIONAL RATES.			
If the party-walls are not entire, or not carried through the roof }	1s.	1s.	1s.
If there be any window or opening into an area, court, or passage, between and common to it and any other warehouse }	1s.	1s.	2s.
or,			
If any wooden lining to any part of the ceilings or walls }			
If any well-hole for hoisting or lighting; or if any other opening in the floors, except for the staircases and teagle rope }	2s.	3s.	4s.
If in plurality of tenure }	Special.	Special.	Special.
If any process of manufacture be carried on . . }	Special.	Special.	Special.
If any stove with more than 3 feet of pipe . . }	Special, but not less than 1s.	Special, but not less than 1s.	Special, but not less than 1s.

The cubical contents of a warehouse are to be computed upon the principle laid down in the Metropolitan Buildings Act, 7 & 8 Vic. cap. 84, Schedule C, viz., the whole space between unperforated walls, from the flooring of the basement to the under surface of the roof, whether in one or more occupations.

MEM.—Where any opening in a party-wall is protected by a wrought-iron door on each side of the party-wall, fitted and hung to such opening without woodwork of any kind (each of such doors of not less than one-fourth of an inch thick in the panels thereof, and distant from the other not less than the full thickness of the party-wall), such wall is to be deemed a complete wall.

London, 29th November, 1845.

APPENDIX.—II.

(See page 201.)

BELL-traps are commonly left loose, because many substances which pass through the grating or strainer of the trap refuse to pass the trap, either floating so that they cannot go under the lip of the bell, or sinking in the well so that they do not get over the standing end of the drain-pipe; and as tea-leaves, rice, and other matters arising from the washing of plates and dishes, the ravelled threads of house-cloths, hair from brooms, and many other such like matters find their way to the grating in the sink, or at the drain-head, and enough of them pass through and lodge in the well into which the bell is dipped, the escape becomes choked, and the trap requires to be lifted to clear the way. To solder down bell-traps is, therefore, to render the sinks useless, unless they are protected from access of such obstructions, or means be devised of clearing them away. They may be protected by a wire strainer over the sink to stop everything that can tend to choke a bell-trap before it can reach the grating;—or any ordinary obstruction may be cleared by forcing all such matters as will pass the grating of a bell-trap to go under the lip of the bell, and to rise over the end of the stand-pipe, and so pass away into the drain, and the requisite force may be obtained from a slight head of water by means of a very simple apparatus that may be always at hand in every house :—A tin or other

cheap metal tube of three or four feet in length, funnel-shaped at each end, and the edges formed or bound with caoutchouc, so that when stood on end and pressed firmly down there may be a water-tight joint. This instrument placed over the grating of any bell-trap so as to embrace it fully, and filled with water, the pressure will be sufficient to clear away any ordinary obstruction from the trap, and render it unnecessary to leave the trap loose. Such an apparatus may be applied by any maid-servant, and to any sink in or about a house, wherever, it must be added, there is clear height enough for it to be placed upright, though it is capable of being articulated to bend in some slight degree; and it may be made telescope fashion to give the means of increasing the pressure if need be.

APPENDIX.—III.

(See page 193, and Note, page 211.)

SUBSTANCE of a REPORT by J. J. RAWLINSON, Esq., of Graythwaite, and the AUTHOR, to the Commissioners of Her Majesty's Woods, &c., upon Preliminary Inquiries into the Provisions of Bills for the Improvement of the Borough of Sunderland. Laid before both Houses of Parliament in March, 1847.

ARRIVING at the provisions, of which the object is to render the town of Sunderland as healthful and as agreeable to its inhabitants as it is capable of being rendered by material improvements within their power, we have to report that the evidence adduced in proof of, and to show the present condition of the town, our own observation, and the admission of all the parties before us, confirmed the facts related to, and found by Dr. Reid, as stated in his 'Report on the Sanitary Condition of Sunderland,' in the Appendix (Part ii.) to the 'Second Report to the Commissioners of Inquiry into the State of large Towns and populous Districts.'* The 'Minutes of Evidence' do but repeat what the local committees found and reported to Dr. Reid, and a statement of what we observed would be but a further repetition of the facts which are recorded in the document referred to.

It was stated to us that many of the streets of the town are badly paved, and that those which have been well paved are, many of them, kept in

* Presented to both Houses of Parliament by command of her Majesty. (1845.)

a bad condition, and this we found upon examination to be the case; but we believe that any attempt to pave the streets, whether carriage-way or footway, properly, or to keep well-paved streets in proper repair, must fail to produce any lasting benefit so long as other things remain as they are. So long as the surface remains uncleansed, or but improperly freed from filth, much of which is of the most penetrating and of the most revolting description; and so long as the streets remain undrained or but imperfectly drained, so long must the pavements of every description, in most parts of the town, continue to be bad, or to become bad almost as soon as they have been made otherwise. But we are disposed to attribute the filthiness of the streets rather to the want of means within the town to be cleanly, and to the necessity which seems to exist thereby of the streets being in a filthy condition, than to any other cause. Matters which ought to pass away unseen, and otherwise unperceived, are either strewn upon the streets or laid in heaps in the courts and alleys, or in back yards, or, indeed, in bins within the walls of the houses, until they can be paraded through the streets under the windows of the most decent, as well as of the least fastidious, of the inhabitants of the town.

It was urged before us, against the present local Commissioners for Sunderland, that the scavenger whom they employ performs his office badly, and that they do not compel him to a proper performance of the duty which he is supposed to undertake. But it was answered on the part of the Commissioners, that they cannot do as they would in the matter; that there is no competition for such an office as that of scavenger of the town, because of the peculiar kind of

plant which it requires, and which not more than a very few persons will provide themselves with, so as to be able to compete for the contract which the Commissioners deem it proper to make on the part of the public with their scavenger. For a profit of about 50*l.* per annum which the Commissioners get upon the contract, the inhabitants of Sunderland are placed at the mercy of whatever scavenger will pay that premium for leave to take away the filth from the houses and from the streets at his own convenience.

We venture to express our belief, however, upon this head, that the streets of Sunderland will not be effectually cleansed while any necessity continues to exist for matters soluble in water to be removed by the scavenger's cart.

It is to be understood that the filth removed by the scavenger from the houses, yards, courts, and streets of the town is esteemed of great value as a manure, and it becomes necessary that the scavenger who pays for leave to collect, and incurs the expense of collecting it, should be allowed a depository or laystall for the accumulations. The depository used by the scavenger for Sunderland is on high ground, at the edge of Sunderland Moor, abutting upon an hospital or large group of almshouses for the widows of decayed mariners, touching the churchyard, and, of course, near to the parish church, and lying south-west of the most densely populated part of the whole borough of Sunderland. This depository had been lately walled round, so as to prevent the south-west wind from sweeping over the filth too closely; but there it is—a source of annoyance and disease, and a subject of well-founded complaint.

An application for powers to make better the sewerage

of a town seems to imply that sewers are already to be found in it. Taking *sewering* in the sense in which it is now understood, to be a provision of subterranean conduits for the removal from the houses of such fluids, and matters soluble in water, as are or soon become offensive to sight or to smell, Sunderland is wholly unsewered. There are some drains into which the surface water finds its way, by means of side channels in the streets, through gully gratings; and as rain falling upon any of the narrower side streets of Sunderland must carry with it, as it rolls along to the nearest accessible gully-grating, some filthy deposit or other, the drains do receive such matters, and receiving them without water enough to render them innocuous, or to carry them through to the Wear, the sides of the drains are bedaubed with the filth, and in dry weather they stink therefrom, and the people put traps to the gullies, and flaps to the outfalls, to keep the foul odours under their feet.

There being no sewers in Sunderland, there can be, of course, no drains from the houses into any sewers; at least, we could not learn from any of the many persons examined before us upon the subject, that any of the common drains are used as sewers, into which the soilage arising in the houses is passed by sub-drains. It is certain that there are water-closets to many houses of the better class in Bishop Wearmouth, but no one of the surveyors or builders, who were called to give an account of the drains and sewers, could tell how the proceeds of such offices passed away, except that they were probably drained off to the ash-pit, or to the middenstead, to be removed from time to time with the contents of those receptacles of filth and refuse. It does not appear that cesspools are used, and

consequently the principal if not the only means of relief which the houses of Sunderland possess are those last indicated—the ash-pit and the middenstead.

It may be proper to explain here that the ash-pit of the north of England is not the mere dust-bin of the south—the domestic receptacle for ashes, cinders, dust, bones, and other similarly dry and generally insoluble refuse of a house, capable of being retained for a few days without offence—but it performs at once the office of privy and dust-bin, or rather of cesspool and dust-bin; for the ashes and cinders are usually brought into a semi-fluid state by the mixed solids, fluids, and soluble matters which are thrown into the ash-pit. Where privies are used, indeed, they are generally so arranged with reference to the ash-pit, that the soil passes at once to the pit; and where water-closets have to be drained, there are no other means of relieving them in Sunderland than the ash-pit, as already intimated.

Nor is it to be understood that the ash-pit is necessarily offensive; for if it be enclosed and decently kept, and if the ashes and cinders be not wholly drowned in excrementitious matters, they check and allay the offensiveness of the excrement and of the animal refuse which go the pit, as the experience of every one in the south must tell him that the decomposition of animal substances thrown into the dust-bin is delayed, and offensiveness prevented, by the antiseptic properties of the ashes and cinders which are deposited with them.

The middenstead of the north is the dung-heap of the south; and, as every house has not a proper ash-pit, the middenstead is made the receptacle of what would otherwise go to the privy or to the ash-pit, with the litter from pig-sties, the cleansing of slaughter-

houses, offal, garbage and refuse of any and of every kind, so that the middenstead is a depository of filth, with no redeeming quality but its value as manure; and because of this value middensteads are cherished rather than denounced; and they are found in courts and alleys, under the stairs, about the doors, and under the windows of dwelling-houses, fostered by the owner as a source of profit, and unnoticed by the indwellers, except for the convenience which the middenstead affords when they have refuse to get rid of.

There are some public privies in Sunderland, and the most conspicuous of them to which our attention was directed, is on the edge of the Moor—near the Sunderland scavenger's depository—the Moor being a piece of undrained land, formerly common, and still uninclosed, but cut in two by the Durham and Sunderland Railway, and otherwise rendered almost useless as a place of amusement, recreation, or disport. The privies by the Moor are in every way offensive, and seem to prove that any public privies which it may be proper to provide, ought not to be of the kind, or in the manner which they exemplify.

Notwithstanding the show of drains and sewers upon some of the plans and sections referred to in the tables and other documents which were put into our hands by the parties promoting the Bills under consideration, we must repeat our impression that Sunderland is to be regarded as a place wholly devoid of those means of relief which ought to exist in every town occupied by human beings, whether it be for decorum or for salubrity. The well-intending surveyor to the Sunderland Commissioners said truly, in his evidence before us, that the best scavenger for Sunderland is a thunder-shower; for rain falling quickly and heavily exerts a

scouring effect, and finding its way from the roofs of houses and other buildings, to the surfaces of the streets, courts, and yards, the filth which it encounters is hurried away, and carried at once down the lanes—some to the drains by the gully-gratings—and some over the quays into the Wear, to be mingled, as the tide rolls out, with the waters of the German Ocean.

But as it regards supplies of water to their houses, people are not so much in the hands of boards of commissioners as the public are in the matter of cleansing and draining; for, when water is offered, any one may take it if they can afford the terms and are willing to accept them. It is one thing, however, for water mains to lie along the streets of a town, connected with the means of an abundant supply, and another thing for the water to find its way into the habitations of the poor. With the supply of water hitherto afforded, most of the inhabitants of Sunderland and Bishop Wearmouth, who were able and willing to pay for it, could have as much as they required for the ordinary purposes of life, and to such persons the supply will be probably more abundant for the same money, and many more will be induced to avail themselves of it; and the more especially as the larger means of the new Water Company will be applied in extending the mains, and in taking the water to places hitherto beyond the supply; but still the miserable courts and alleys, where water is even more wanted than in the wider streets, must be passed by; or if the mains be laid in them, the houses will, for the very poverty of their squalid inhabitants, or rather perhaps for want of a due appreciation on their part of the blessing lying at their feet, remain unsupplied; and the poor will have still to

carry their skeels or buckets to the pant, and pay their farthings for the fluid, as it is poured out by such measure to them.

We have already intimated that one part of the measure proposed by the Corporation goes to enable the Town Council of the borough to possess themselves, for the public, of the interest of both the newly incorporated Gas and Water Companies ; and we are strongly impressed with a belief that such a project, if wisely secured as to its efficiency, and well protected from abuse, may be adopted with the greatest advantage and that it may become of incalculable benefit to the town. Whether the Town Council is the proper body to be charged with the duties of managing such matters for the public, is a question beyond that of the merit of the project, and one which we are not called upon to advise about ; but, as to the project itself, we respectfully submit that it is deserving of the most serious consideration, with a view to its adoption in such a form as shall lead to the proper lighting at night of every street, court, and alley in Sunderland, and to the supply of every dwelling in the town with a perennial stream of pure water. We submit that such a project as that implied in the scheme propounded by the Town Council of Sunderland for supplying water to the public, *by the public* is capable of being made the means of denying to individuals, for their own good as well as for the good of the community, any option in the matter, by supplying every house with water, as every street is, or ought to be, supplied with gas ; imposing the expense of laying the water on in every house upon the house, and defraying the cost of the supply of water by a rate upon the locality, as the cost of gas-light in the streets is defrayed ; whilst the

essential apparatus of services and cisterns could be placed under the guardianship of the police, and be otherwise protected by penalties as gas services, lamp-posts, and lamps are protected.

With such a plan well carried out, sewers under the streets, and drains from the houses into the sewers, will be a further means of cleanliness; and something of the kind here indicated, or something else that shall make both house-drains and common sewers in effect watercourses, and not mere troughs for undiluted and unsolved excrement, is, in our opinion, necessary, even to justify the formation of a system of soil drainage in a town situated as Sunderland is, or, indeed, in almost any town, however it may be situated.

Cleansing and sewerage are almost convertible terms. No town can be thoroughly cleansed without being properly sewered; and every town that is properly sewered is in a condition to be perfectly cleansed; for the removal of solid or otherwise insoluble dry matters is not more to be regarded as one of the processes towards cleanliness, than the disposal of worn-out garments is to cleanliness of person; it may affect the decency, but it has no necessary bearing upon the wholesomeness of the body.

Sewering must be understood, however, to imply something more than a provision of drains and culverts as conduits for fluid refuse, or refuse capable of being made fluid; it must be taken to imply also the means of rendering fluid such refuse as may pass away by drains, and to such effect that it shall pass away.

But the sewerage will be very imperfect which does not provide for the removal by proper vents of the exhalations arising from the foul matters which pass into sewers by house-drains; and, indeed, for the

removal of such exhalations from the house-drains themselves.

The elevation of the site of the town of Sunderland on both sides of the river which runs through it, gives such ample fall in every direction as to render the perfect sewerage of the town most easy, so far as elevation and consequent fall are essential to the process of sewerage. But we have already said, and we repeat the assertion, that facility of escape for the matters which should pass away by sewers, will not alone justify the building of sewers for their reception, or the formation of house-drains for the conveyance of such matters to the sewers. There must be the means of diluting and of hurrying away such matters through the drains and sewers, from the houses and from the inhabited localities, to render the sewer preferable to the cesspool, inasmuch as the sewer exposes a larger surface of the soil to the action of the external air than the cesspool does.

The substitution of the decently enclosed privy over a covered cesspool, for the tub and ash-pit of the north of England, would seem to involve a great improvement, and that it would have a humanizing tendency cannot be doubted; but it may be questioned whether the deposit of excrementitious matters in cesspools formed in the close back-yards of houses in thickly populated towns, unallayed by the concomitants of the ash-pit, would be a change for the better; while it may be confidently asserted that the substitution of the mere drain and sewer for the still cesspool would be a change for the worse, unless the privy became at the same time a water-closet to ensure, by flushes of water, the passage of the soil through the drains, and unless the discharge of the drains were followed by a liquid current in the

sewers more pure than the matters discharged into them by the drains.

The water-works in progress for raising water with which to supply Sunderland must possess sufficient power to lift the water a height of from 200 to 300 feet, from the stratum of sandstone in which it is found, to a level sufficiently high to supply the houses in the town in their upper stories. But 1,000,000 or even 1,200,000 gallons of water per diem, the quantity calculated upon by the Water Company, will not be enough for a town containing 60,000 inhabitants, if every house have its water-closet, and if water be used as freely for all the purposes of life as it ought to be used, and afford also the means of a constant current through the sewers of the town.

And, indeed, with the sea close at hand, and at hardly 100 feet below the level of the highest ground in Sunderland, it would seem to be wholly unnecessary to charge the Humbleton Hill Waterworks with the duty of raising water 300 feet high to do what sea-water will do as well. It is not undeserving of consideration, at the same time, that subterranean supplies of good water are not always inexhaustible; and it may be well not to tax the water in the sandstone under the Sunderland district with a duty which may be performed by less precious water from an unvarying and never-failing source.

From whatever source, however, the water may be obtained, we again repeat—for it cannot be repeated too often—that a run of water is essential to sewerage; for without water sewers in a town will inevitably become causes of offence and sources of disease. Much may be done that is not done in arranging for the discharge of rain-water from the roofs of the buildings of towns;

for if these be so disposed with reference to the drains, or if the drains be so placed with reference to the roofs, that all the water falling upon the roofs shall be brought down by trunks, or upright pipes, to the higher level of the drain in every case, and above the inlet for the excrementitious and other foul matters from the house, a valuable scour, that is too frequently wasted, would be secured to house-drains, and, incidentally, to the sewers. But the practice of flushing sewers with their own foul contents ought not to be extended to Sunderland; the effect of the process being to bedaub the inside of the sewer to a high level with filth, and then to leave such increased surface exposed to the air, a fruitful source of the foul exhalations which so often turn the intended good into an evil. Nor can the application of gratings in the carriage-roads over sewers, for the purpose of ventilating them, be otherwise spoken of than as tending to a more impartial distribution of the foul air from the sewers to the houses on both sides of a street, than is afforded by the diagonally alternating side gully-gratings.

It is suggested, then, that in connexion with any sewers throughout the town of Sunderland, tanks should be formed on the summits of the ridges on both sides of the Wear, and that water be thrown up to them from the sea. The expense of a very small supply of fresh water, from any attainable source, with which to scour the sewers, would suffice to raise water enough from the sea to such tanks to afford a constant run through the sewers, and to furnish means of watering the streets in the summer season, whilst the tanks or reservoirs might be also available as baths, accessible at all times without reference to tide or

weather, and free from every objection, as the change of water would be constant ; while, a small charge for the use of such baths would go far, in all probability, to defray the expense of lifting the water in a place where, from the cheapness of coal, power costs so little as it does at the waterside in Sunderland.

But besides keeping up a constant current of pure water through all the common sewers, to carry off the matters which they would receive from the house-drains, it is necessary that the foul gases which will, under any circumstances, be evolved from them in their passage, should have some other vent than the gully-gratings in the streets and the sinks in the houses. Ventilating shafts should be built in connexion with the main sewers at the higher ends, by which shafts the foul and poisonous air may pass off unperceived, and innocuously, into the upper air ; and in every new building one or more flues should be formed in some of the walls, in connexion with the soil-drain for the same purpose ; and such flues as those last indicated might, indeed, be built with great advantage to existing buildings to ventilate their drains. Care must be taken, however, that the outfalls of the sewers be not stopped by flaps or valves, or that air be admitted by shafts to the sewer at the lower levels, to allow of the escape of the foul air by the process which its levity will induce, if circulation be not denied by the exclusion from the sewers of the denser external air at the lower levels. Flaps applied to the gully inlets will prevent the escape of foul air from the sewers into the streets, and bell and other less expensive traps will prevent it from rising out of the drains into the houses.

It may be added, that the suggested ventilating

shafts at the upper ends of sewers need not be placed in the roads to obstruct the public ways, inasmuch as they need not stand directly over the sewers, nor need they be obtruded upon the eye, even if it be necessary to make them unsightly objects—a necessity which can hardly be proved to exist—unless, indeed, it be deemed necessary to obtain designs for such shafts by advertisement to architects, in which case the town which commits the folly must submit to the unsightly and expensive consequences which are likely to result from such a course.

As the effect of properly and thoroughly sewerage the whole of the town of Sunderland will be to leave but little of the soil which is now collected and applied as manure, to be removed by the scavenger, a waste to the extent of the value of the manure must be the consequence, unless the same matters be intercepted on their way to the river or to the sea, and returned, to be applied as manure, in the manner recently proposed in London. How far the use of salt water to cleanse the sewers would affect the character of the liquid they would give out, for the kind of culture employed in the neighbourhood of Sunderland, we are not prepared to state, but it is certain that the salt would improve rather than injure the manure for most of the purposes of agriculture. However this may be, fresh water can, of course, be applied to the cleansing of the sewers, if the value of the liquid emitted by the sewers will be so much greater therefrom as to make it worth the great cost of fresh water.

THE END.

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